

**STUDIES OF TWO RARE TIGER BEETLES
(*CICINDELA PURITANA* AND *C. D. DORSALIS*)
IN MARYLAND, 2011**



Photo by Chris Wirth

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ABSTRACT

*This report includes the results of continuing monitoring of *C. puritana* and *C. d. dorsalis* at all sites in Calvert County, the Sassafras River mouth and Janes and Cedar Islands, Maryland, plus several additional surveys and studies in 2011. Sites surveyed and methods are the same as in other recent monitoring reports. **Puritana surveys.** The **total number of adult *C. puritana* at all Calvert sites in 2011 was 2769 compared to 3043 in 2010.** Other recent counts were 2118 in 2009, 5721 in 2008 (the highest count since 1998), 2625 in 2007 and 3946 in 2006. Results indicate an apparent pattern since 1996 of alternate year abundance in which odd year cohorts have lower counts than corresponding even years (except of 2002). The 2011 counts among individual sites differed from 2010 in having significantly lower numbers at Little Cove Point (203 versus 554), Calvert Cliffs State Park (572 versus 1102), and Western Shores/Calvert Beach (110 versus 402). Numbers increased significantly at Warrior rest (1256 in 2011 versus 534 in 2010) and at Scientists Cliffs (183 versus 26). There were as last year a large number of breakdowns and slumps at Little Cove and Cliffs of Calvert that may have contributed to the decline. **The 2011 count for the Sassafras metapopulation was 1514,** a significant decline from the 2705 in 2010. Other recent counts were 837 in 2009, 1770 in 2008 and 1566 in 2007. The 2011 count include continuing highest at Grove Point, but also high counts (but less than 2010) at West Turner and East Lloyd. An additional site, Grove Farms WMA, located east of Grove Neck and a potential translocation site was also surveyed but no *C. puritana* were present.*

***Dorsalis.** The total count for adult *C. dorsalis* at all Calvert sites in 2011 was 436 compared with 589 in 2010. This indicated a significant two years of increase since this the lowest ever count of 78 in 2009. No adults were found at Flag Ponds again in 2011 confirming the loss of this population which had been on the verge of being lost with 6 adults in 2009 and 2 in 2008. All adults in 2010 and 2011 were thus at Western Shores. Other recent counts at this site were 716 in 2007 and 188 in 22008. The distribution of adults at Western Shores was essentially the same as in other recent years.*

***Vegetation Removal Study Sites.** The 2011 peak counts at the 5 cliff sites were significantly lower in 2011 than in 2010, but a comparison of control versus vegetation removal sites indicate an apparent positive effect of removal on adult numbers. Mean 5-year adult counts for the removal sites (A, D) was 368 compared to 241 pre-treatment (2 years of counts) while the mean numbers for the control sites decreased from 440 to 204.*

*Surveys of **Janes Island** produced a count of 1087 in 2011 compared to 1163 adults in 2010. Other recent counts were 1330 in 2009 and 3081 in 2006. **Cedar Island** had 1691 adults in 2011 compared to 1439 in 2010. Other recent counts were 974 in 2009 and 2454 in 2006. We conducted additional surveys north and west of Cedar Island and located 6 small sandy beaches north of Janes with small numbers of adult *C. dorsalis*, ranging from 6 to 32 individuals. It is uncertain if these are viable populations or dispersal sites. No *C. dorsalis* were found at other mostly island sites west of Janes. .*

INTRODUCTION AND METHODS

Annual surveys for adults of *C. puritana* and *C. d. dorsalis* have been conducted at all Maryland sites since 1988, and are among the longest period of monitoring population size for any insect species. The primary objective in 2011 as in all previous years was to determine the distribution and abundance of these two species at all current sites in Maryland so counts can be compared with previous years and trends of abundance identified. In all years we have used the same methods and conducted surveys during the season of peak adult abundance and most often on days when conditions are optimum. This has provided an understanding of population dynamics at various sites and given insight on implementing protection and management strategies. Earlier studies showed that peak abundance is typically from the last week in June through mid-July. All surveys in 2011 were conducted between June 28 and July 8, on days that were sunny with temperatures in the mid 80's to low 90's. Most sites were surveyed at low to mid-tide and when the sun was on the beach and cliff base. Under these conditions a high level of adult activity is expected. If conditions were different on a particular survey day, it is noted below. The survey method we used, as in previous years, involved one person walking slowly along the shoreline near the water edge and counting all adults that were seen on the ground surface 5-10 m ahead. In areas where there was a narrow beach or cliffs near the water, the base of the cliffs was also examined and beetles there included in the count. In sections of wider beach the surveyor moved more slowly so the back portions of the beach could be surveyed. Since 2004 counts have been made and reported within the same sections of shoreline and these verified using a GPS unit to reference these specific locations. These locations are shown as numbered waypoints on topographic maps included with this report and the adult numbers within these sections shown in Tables below. In addition, in 2011 as in 2010 we made counts at several sites within shorter lengths of shoreline to provide additional detail of distribution and abundance. Shoreline characteristics were recorded for each of these sections and included in the report tables. In 2011 we also resurveyed a new small *C. puritana* site found in 2010 north of Grove Point and surveyed additional sites in the Upper Chesapeake Bay for *C. dorsalis*.

RESULTS AND DISCUSSION

Summary of Calvert *C. puritana* Trends. The total number of adult *C. puritana* at all **Calvert sites in 2011 was 2769 compared to 3043 in 2010**. These counts compare with other recent counts of 2118 in 2009, 5721 in 2008 (the highest count since 1998), 2625 in 2007 and 3946 in 2006 (Table 1, Fig. 1). The interesting and apparent pattern since 1996 reflects an alternate year abundance overall and at most sites in which odd year cohorts have lower counts than corresponding even years (with the exception of 2002). The 2011 counts among individual sites differed from 2010 in having significantly lower numbers at Little Cove Point (203 versus 554), Calvert Cliffs State Park (572 versus 1102), and Western Shores/Calvert Beach (110 versus 402). Numbers

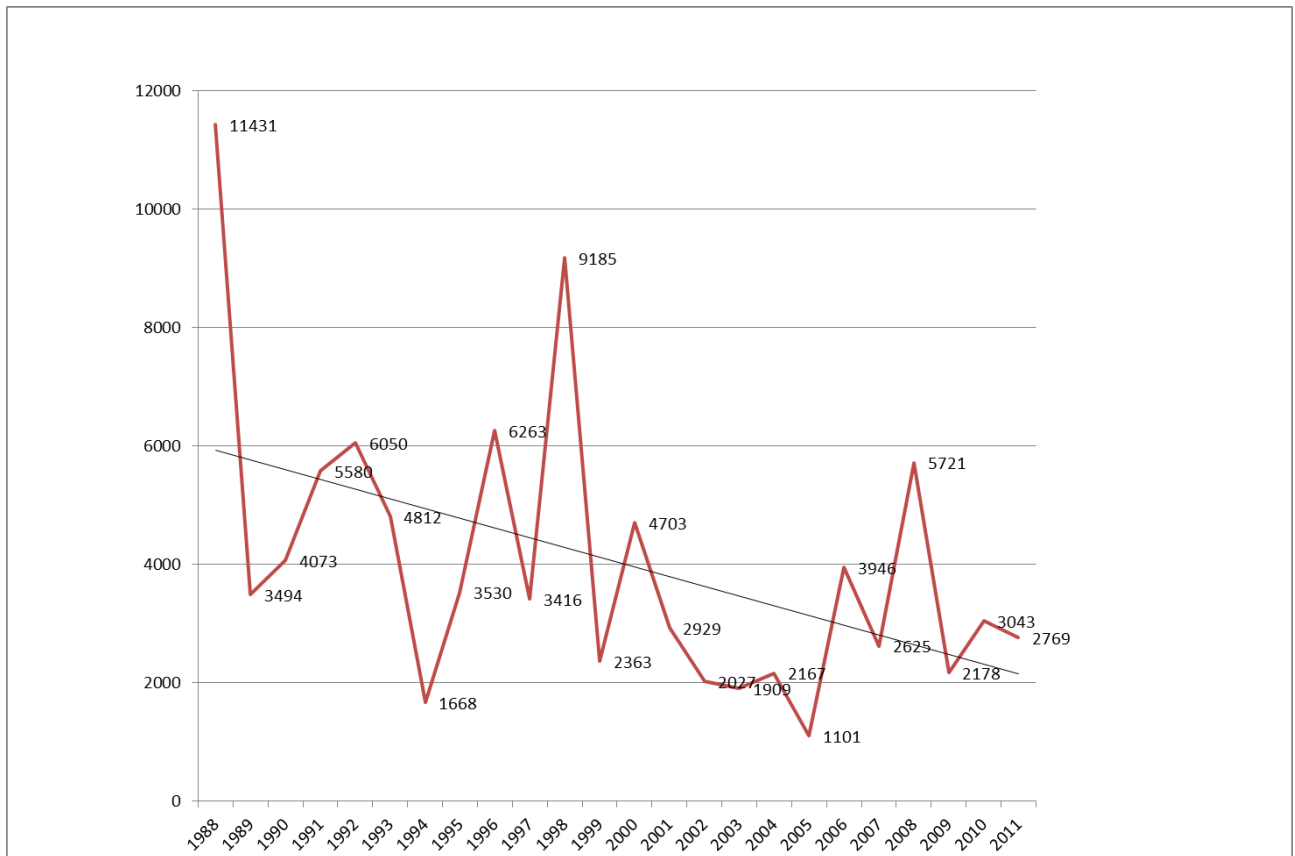
increased significantly at Warrior rest (1256 in 2011 versus 534 in 2010) and at Scientists Cliffs (183 versus 26). Other sites did not change as much. The 2011 count includes a new site first recorded in last year's report between CC Nuclear Power Plant and CC State Park, called Rocky Point, had 98 adults (compared to 72 last year).

As mentioned in last year's report there were again a significant number of new breakdowns and slumps (at least 11 found) along the Little Cove and Cliffs of Calvert sections of shoreline. Four breakdowns were also seen along Calvert Cliffs State Park while no other significantly shoreline or cliff changes were observed. Although cliff breakdown is a normal occurrence at the Calvert PTB sites, observations suggest this has been greater in 2009 to 2011 than most other recent years, especially in the southern sites (see below).

Table 1. Total index counts for C. puritana at all Calvert County sites, 1986 to 2011.

Year	Rand	CRsv	Bays	Wrest	ScCl	WS+CB	CCNP	RckPt	CCSP	LCov	CofC	Total
1986	200	20	72		1000					250		1542
1988	93	73	22		3571	4891			2194	328	259	11431
1989	119	4	6		1491	1052			702	85	35	3494
1990	133		64		1342	1747			643	102	42	4073
1991	57	17	38		2057	1653			835	738	155	5550
1992	65	10	75		2029	767			2565	232	307	6050
1993	68	2	68		2007	731			1177	538	221	4812
1994	24		19		681	101			756	87		1668
1995	82	12	119		1146	1150			541	340	140	3530
1996	45	0	66		1904	1489			919	927	913	6263
1997	75	2	51		1091	851	119		507	525	195	3416
1998	83	1	44		3792	2597	616		984	566	502	9185
1999	29	0	41		408	1169	49			373	294	2363
2000	11	0	22		2317	1161	367			462	363	4703
2001	234	2	109		1375	502				352	355	2929
2002	52	0	28		691	621	80			397	158	2027
2003	31	0	149		256	577	226			586	84	1909
2004	27	0	0		447	1279	121			251	42	2167
2005	31	0	2	155	111	232			242	298	30	1101
2006	25	0	6	1366	218	1123	105		338	612	111	3904
2007	21	0	14	631	206	273	276		292	740	172	2625
2008	23	0	5	958	218	841	122		1609	1116	829	5721
2009	7	0	1	466	45	143	241		666	330	219	2118
2010	31	0	20	534	26	402	191	72	1102	554	111	3043
2011	33	0	37	1256	183	110	213	98	572	203	64	2769

Fig. 1. Total index counts for *C. puritana* adults in Calvert County, 1988 to 2011.



Accounts for Individual Calvert Sites. Table 3 below gives the detailed results for all Calvert sites in 2010 along with years 2004-2009. This is the same table used in reports since 2004. Included are the numbers of adult *C. puritana* within each waypoint section, shoreline characteristics for each section, and the coordinates for each waypoint. The locations of these waypoints are shown on the topographic maps included in the appendix of this report. In addition, a new table (Table 4) provides additional counts for subsections within the standard waypoints at several important sites (Cliffs of Calvert, Little Cove Point, Calvert Cliffs State Park, Western Shores/Calvert Beach, and Warrior Rest).

Randall Cliff. This is the northernmost *C. puritana* site in Calvert County that has had consistently low numbers, and especially low in recent years. Numbers of adults have been less than 100 since 1990, except for a count of 234 in 2001. The count of 33 adults in 2011 was comparable to those in most other years. A low count of 7 adults was

reported in 2009 and a range of 23 to 31 from 2003 to 2008. No obvious shoreline or cliff changes were observed in 2011. The explanation of the low numbers at this site is probably because of the limited suitable cliff substrate for larvae (seemingly too dry and with too little sand content). The shoreline is also very narrow with little adult foraging area. Typically, all adults have been found in the few scattered patches of wider beach or in the large public beach (Brownies Beach) at the north end. There seems to be evidence of progressive and significant erosion throughout this site, especially the southern portion in the past 10 years that has eliminated some former habitat. Throughout the length of the site the shoreline has narrowed as evidenced by the need to wade through deeper water, even at low tide, to access the small patches of exposed sand where adults occur.

Camp Roosevelt. As in each survey since 2002, no adults were found at this site again in 2011, further confirming the loss of this population. Even in earlier years counts at this site have been low, although 73 adults were found here in 1988. Records from collectors in the 1950's and 1960's suggest this site may have once supported a larger population. This site includes a long length of shoreline and cliffs, but much of the beach is narrow and/or with dry cliffs with little sand content, and little apparent suitable oviposition and larval habitat.

Bayside Forest. A total of 37 adults were counted at this site in 2011, the highest count since 149 in 2003. Other recent counts were 20 in 2010, 1 in 2009, 5 in 2008, 14 in 2007, 6 in 2006, 2 in 2005 and none in 2004. There were only 6 adults in 1989, but most other earlier years had 40 or more adults. In all years since 2004 all or most beetles have been in the area of waypoint 3. Observations during the 2004 survey indicated this site experienced very severe erosion due to Hurricane Isabel. Most of the shoreline and especially the southern portion where beetles were always most common lost several meters or more of cliff face with extensive cliff breakdown and trees littering the beach and cliff base. There were also tracks and compaction from heavy equipment on the beach, apparently being used to clear the beach of downed trees. In 2005 there was no evidence of the downed trees and rubble or of heavy equipment on the beach. By 2007 to 2009 it appeared that the beach and cliffs have generally recovered from these earlier disturbances, but there was no evidence of the beetle population recovering until last year and that recovery seems to be continuing with the higher count in 2011. There has also been ATV activity at this site in the past 6-7 years which may be having a negative impact.

Warrior Rest and Scientists Cliffs. This very long section of shoreline has been separated in recent years into two sites because of differences in ownership and management. In previous years the beetle counts were combined and listed as Scientists Cliffs. The Warrior Rest count in 2011 was 1256, the highest count since 1388 in 2006. It compares with 534 in 2010, 466 in 2009, 958 in 2008, and 633 in 2007. These counts indicate a viable and robust population at this site with beetles occurring at very high densities. The only site changes noted in 2011 were two breakdowns. The distribution of adults at this site in 2009 was similar to other recent years with highest densities at waypoints 36-38 (especially the 535 in 38) and lower densities in the northern portion of the site. An interesting aspect of this site is that most of the shoreline has a narrow to very

narrow beach, yet densities are extremely high, apparently because cliff habitat is ideal for recruitment and larval survival, and adults are able to forage successfully along the cliff base and face for extended periods.

The Scientists Cliffs population count was a surprising 183 in 2011 compared to the lowest ever counts of 26 in 2010 and 45 in 2009. Other recent counts were 218 in 2008, 206 in 2007, 213 in 2006 and 111 in 2005. As in past years most beetles were absent or at very low numbers in most waypoints sections of the long northern section of this site which has groins nearly throughout its length. The adults present, especially in the past two years, were concentrated in the few localized areas of bare cliff face. The 2010 report indicated several sections of large breakdowns creating or increasing potential recruitment habitat and may have resulted in the significant numbers of adults in these areas in 2011. It is uncertain if these adults emerged from the new suitable habitat or dispersed south from the high density of adults at Warrior Rest. In any event, they may be successful in recruiting larvae in these patches in the next few years. Observations in recent years suggest that much of the suitable habitat along the middle and northern section of Scientists Cliffs (the long section adjacent to Warrior Rest) has deteriorated due to increasing vegetation, apparently caused by the very extensive groin field along this portion of the shoreline. Another more significant pattern was a continued dramatic decline of beetles in the south section of the site (waypoints 51-59); only 19 adults in 2011, 3 in 2010, and 14 in 2009 compared to over 50 in all years from 2004 to 2008. The cause of this decline is likely a result of progressive vegetation growth on the cliffs since groins were placed here about 10 years ago.

Western Shores/Calvert Beach. These two sites have been combined because they are adjacent shoreline sections and have comparable private ownership. This is also logical because they are part of the same section of shoreline and the same populations of *C. puritana* and *C. dorsalis*. This is the only current site in Maryland with populations of both species. The total number of *C. puritana* in 2011 was 110, the lowest count since the 101 in 1994. It compares with 402 in 2010, to 145 in 2009, 841 in 2008, 273 in 2007, 886 in 2006, and 232 in 2005. These recent counts as at several other sites can be quite convincingly explained by the pattern of alternate year abundance. Odd year cohorts have been lower in most of the past 10 years at this site and even year cohorts significantly higher. As in previous years, the *C. puritana* were restricted to the middle section of this site (the southern end of the Western Shores and northern part of Calvert Beach) where cliffs are very well developed and beaches wider than most other *C. puritana* sites. Although observations indicated that Hurricane Isabel improved the habitat at this site by washing out some of the back beach vegetation and pushing sand onto the beach, this site continues to experience rapid back beach and low cliff vegetation growth. This vegetation now includes larger trees and dense shrubs which probably block the movement of adults of *C. puritana* up and down the cliffs as they switch from foraging on the beach to oviposition on the cliff face. The population here may still be viable, but the trend, supported by the low count in 2011, seems to be declining adult numbers along with deteriorating habitat.

Calvert Cliffs Nuclear Power Plant. This shoreline site has supported a moderate population of *C. puritana*, with highly variable counts over the years (high of 616 in 1998 and low of 49 in 1999). The count in 2011 was 213 and similar to the 191 in 2010 and 241 in 2009. Other counts were 122 in 2008, 276 in 2007, 109 in 2006, and 121 in 2004. The distribution in 2011 as in most other years indicates adults are most abundant in the southern part of the site (waypoints 115-118) where there are wider beaches along with suitable cliffs. There was also moderate abundance of beetles in the middle of the shoreline but very few adults in the northern third. Nearly all of this site, except the southern end, has a very narrow and very rocky beach which is not optimum for adult foraging and contributes to the overall lack of suitable habitat in these areas. A new site called Rocky Point was surveyed in 2010 and 2011. The count here was 98 in 2011 and 72 adults in 2010, all adults found at 5 small patches of open beach among this very narrow shoreline section. Cliff habitat in this section appears to be of relatively high quality but beach area is very less than optimum because it is narrow and rocky .

Calvert Cliffs State Park. This year's count of 572 compares with counts of 1102 in 2010, 666 in 2009 and 1609 in 2008. Other recent years' counts were 292 in 2007, 338 in 2006, and 242 in 2005. In all years, adults have been abundant along the three major cliff sections of the site which are separated by two marsh beaches. Increases in 2008 to 2010 were seen in all of the waypoint sections (except 202), and especially at waypoints 201-203 and 207. No counts were made at this site from 1999 through 2004, but from 1988 to 1998, counts were over 600-700 in most years, with a peak of 2194 in 1988. The site has experienced significant shoreline and cliff erosion resulting in closure of the cliff sections to the public about 8 years ago, but despite the narrowing of the beach, the site continues as very good habitat. Three new breakdowns were observed at this site in 2010 but none were observed in 2011 nor were there any other obvious shoreline or cliff changes.

Little Cove Point. This long section of shoreline has extensive cliffs and mostly narrow to moderate width beaches. It has consistently (except for a very few years) supported a medium to large population of *C. puritana*. The count declined to 203 adults in 2011, the lowest count since 87 in 1994. This count compares with 554 in 2010, 330 in 2009, 1116 in 2008, 292 in 2007, 338 in 2006, and 242 in 2005. The 2008 count was the highest ever and compares with the previous high counts of 927 in 1996 and 738 in 1991. New breakdowns and slumps (11 total) were observed at this site in 2011 as was the case in 2009 and 2010 (six breakdowns and several slumps). While these erosional events create new habitat they may result in increased population size, there may be localized or overall loss of individuals and population decline in some years if breakdowns are very extensive. The distribution of adults in 2011 was general similar to other recent years but numbers lower in most sections than in 2010, especially in waypoint sections 150 to 159. The site overall continues to have good cliff habitat and suitable beaches, but has deteriorated in several sections as a result of new shoreline modifications (reef balls and revetment). In recent years, several of these modified sections had small numbers of adults on the adjacent beach, other sections had no adults (Table 4).

Cliffs of Calvert. This site borders the above site is a part of the same *C. puritana* population. The adult count in 2011 was 64 and continues a trend of significant decline from 829 in 2008, 219 in 2009, and 111 in 2010. The decline at this site in the past three years could be a result of new erosional events and/or shoreline structures. The breakdowns here in 2009, 2010 and four more in 2011 have affected a much higher proportion of the shoreline than at Little Cove. Few adults have been found in these breakdown sections. There were also 3 sections of revetments or riprap where few beetles were found. As in previous years, most of the adults in 2011 have been in the middle section of the site, waypoints 179 to 186, but at much lower numbers.

Summary of Calvert County *C. d. dorsalis* Trends. The total count for adult *C. dorsalis* at all sites in 2011 was 436 compared to 2010 in 589, 72 in 2009 and 188 in 2008 (Table 2). The 2011 count represents a second year of increase following two years of the lowest ever counts in 2008 and 2009. The 2010 and 2011 counts are only for Western Shores since no adults were found for the second year at Flag Ponds. Numbers there have been declining significantly in recent years and are now apparently extirpated from that site. Overall, the Calvert *C. dorsalis* metapopulation has experienced a progressive, stepped and significant decline of abundance since the early to mid-1990s when numbers ranged from 3000 to over 10,000 and included viable populations at Flag Ponds, Scientists Cliffs and Cove Point. Numbers were as high as 3014 in 2003, even with the significant decline of the Cove Point and Scientist Cliffs populations in 200. Totals then declined to relatively consistent counts in the 700s from 2004 to 2007. There was another significant decline to 190 in 2008 and 78 in 2009 before the increase of the only remaining population at Western shores (Table 2, Fig. 2).

Warrior Rest/Scientists Cliffs. Two sections of the shoreline at this site supported populations of *C. d. dorsalis* in the 1990s and until 2003. A moderate sized population became established on the beach near the mouth of Parker Creek in 1991 but disappeared by 1994. It is uncertain if these were immigrants from the Scientists Cliffs site to the south, but it seemed apparent that the habitat was not suitable for sustaining a viable population, probably because of its small size and narrow beach that was subject to frequent overwash. A larger and more persistent population became established in the public beach area at Scientists Cliffs in 1988, but after a progressive increase to 2465 in 1991, numbers began a dramatic decline, disappeared by 2001 and have not been found since. Small numbers of adults have been found in some years at the far south end of Scientists Cliffs, but none were found in 2006-2010, and it is apparent this area is unsuitable for sustaining a population.

Western Shores/Calvert Beach. The number of *C. dorsalis* at this site was moderate but unusually consistent from 2004 to 2007 (716 in 2007, 699 in 2006, 623 in 2005 and 627 in 2004). Then numbers dropped precipitously to only 188 in 2008 and 72 in 2009 before the significant increase to 589 in 2010 and 436 in 2011. Distribution of adults within this site has been similar in most recent years with highest concentrations from waypoints 65 to 68. In 2011 there were more adults counted at waypoints 69 to 76 and fewer to the south at 77 to 84 than in most other recent years. After 2004 and 2005 there has been a more southward shift in the distribution.

Flag Ponds. The number of adult *C. dorsalis* at this site declined dramatically in recent years, to 2 adults in 2008, 6 in 2009, and none in 2010 and 2011, indicating the loss of this population. Numbers at this site had been consistently low since 2004 with counts of 51 in 2007, 61 in 2006, 121 in 2005 and 80 in 2004. The decline here has been significant and progressive since the mid-1990s when there were consistently over 1000 adults. Numbers were even higher into the early 1990s when they reached peaks of over 3000 in several years. The only high count (over 225) in the past nine years was 748 in 2003. That count suggested the population was building back up as adults were recruiting significantly in the northern part of the shoreline at the site. The declines in 2004 and 2005 could have been due to impacts from Hurricane Isabel eroding out many developing larvae in September 2003, thus reducing numbers of adults emerging in 2004 and 2005. However, if the habitat was suitable recovery from this event should have occurred within a few years as was seen in many Virginia sites. As noted above regular use of a small 4-wheeled vehicle for patrols by park personnel along the shoreline and increased human foot traffic in the past 5-8 years may contributed to the decline, especially after numbers dropped to the recent low levels.

Cove Point. The population at this site experienced gradual but progressive decline during the 1990's until 2004 when only 11 individuals were counted, and none since then. As with the above Calvert sites, there is no obvious explanation for the extinction except that the section where most beetles occurred in later years was a section that has experienced significant erosion, including a major erosion event in 2008.

***Cicindela dorsalis* Population Trends.** In the early 1990's there were four large populations of *C. dorsalis* in Calvert County. The population at Cove Point declined gradually throughout the 1990's and was gone by 2003. At Scientists Cliffs there was a larger population peaking at 2465 in 1991, before experiencing an even greater decline to extinction in 2004. The two populations at Flag Ponds and Western Shores have been the largest and most persistent, but these also declined significantly from the mid-1990s to the present, reaching lowest ever counts in 2008 and 2009 and the Flag population lost in 2010. There has been no obvious cause identified for this recent major decline, but shoreline changes (the formation of the spit) at Flag eliminated the section of beach where most of the population occurred into the early 1990's. Beetles never really increased in the new spit which formed adjacent to the original shoreline, and numbers remained relatively low since 1997, except for one year (2003) when over 700 were counted.

Compared to many *C. dorsalis* population in VA and those in Maryland's Eastern Shore (Janes and Cedar), the size of shoreline habitat occupied by Calvert *C. dorsalis* is small, especially Scientists Cliffs and Cove Point, and even at Flag Ponds after the spit formation. That could be a factor contributing to the decline, especially where the habitat is not of high quality. Beetles have occupied a much greater portion of the shoreline at Western Shores, and the distribution has changed somewhat over the years. It is possible that when these populations drop to levels of less than 200-500 they are doomed to extinction because of the effects of small population genetic (inbreeding depressing) or ecological (Allee effects) factors, as occurred with the Cove, Scientists Cliffs, and Flag

Pond populations. Human impacts may also be involved, perhaps not a singular cause, but a contributing factor when populations are stressed or at low numbers. The localized beach where *C. dorsalis* occurred at Scientists Cliffs was quite heavily used, more so during the time of decline. It is difficult to determine if beach walkers have caused impacts at Flag, but that along with the use of a small 4-wheel vehicle (“Mule”) to monitor the beaches several times per day may be having effects on larval recruitment and development. There has also been evidence of 4-wheel vehicle use in a section of Western Shores in the past several years. This seems minimal and probably not a major factor. Another potential factor is a change in sand particle size on the beach which seemed to be significantly coarser at least at Flag Ponds, compared to earlier years. Despite the significant increase in numbers at Western Shores in 2010, the Calvert population remains susceptible to extinction. There is also an extensive offshore bar along the Flag Ponds and Western Shores section which could have increasingly stabilized the shoreline and impacted the habitat.

Table 2. Index counts of total *C. dorsalis* population for all Calvert County sites, 1986-2011.

Year	CRsv	Bays	PkM	ScCI	WS+CB	Flag	CCSP	Cove	LCov	CofC	Total
1986	0	0	0	0	3500	500	0	100	0	0	4100
1988	3	0	0	464	4157	2857	0	427	0	0	7908
1989	0	0	0	1634	3392	3084	1	202	0	0	8313
1990		20	0	1874	1479	2188	0	707	0	5	6273
1991	16	37	328	2465	4198	3995	0	406	5	0	11450
1992	0	10	752	1189	3407	4351	1	335	1	1	10047
1993	0	2	49	473	1344	1218	0	196	7	0	3289
1994		9	0	633	3860	1445	0	278	0	0	6225
1995	8	4	0	688	2450	1080	0	188	0	0	4418
1996	1	5	5	673	1380	810	0	192	3	0	3069
1997	0	0	15	510	841	216	0	32	0	0	1614
1998	0	0	0	263	418	68		32	0	0	781
1999	0	0	0	23	1639	210		56	0	0	1928
2000	0	1	7	24	2813	171		22	0	0	3038
2001	0	0	1	0	1353	221		11	0	0	1586
2002	0	4	0	31	1635	130		13	0	0	1813
2003	0	0	1	13	2209	748		42	0	1	3014
2004	0	0	0	0	627	80	4	11	0	0	722
2005	0	0	0	0	623	121	0	0	0	0	744
2006	0	0	0	0	699	61	0	0	0	0	760
2007	0	0	0	0	716	51	0	0	0	0	767
2008	0	0	0	0	188	2	0	0	0	0	190
2009	0	0	0	0	72	6	0	0	0	0	78
2010	0	0	0	0	589	0	0	0	0	0	589
2011	0	0	0	0	436	0	0	0	0	0	436

Fig. 2. Graph of index counts for the total population of *C. d. dorsalis* at all Calvert County sites, 1986 to 2011.

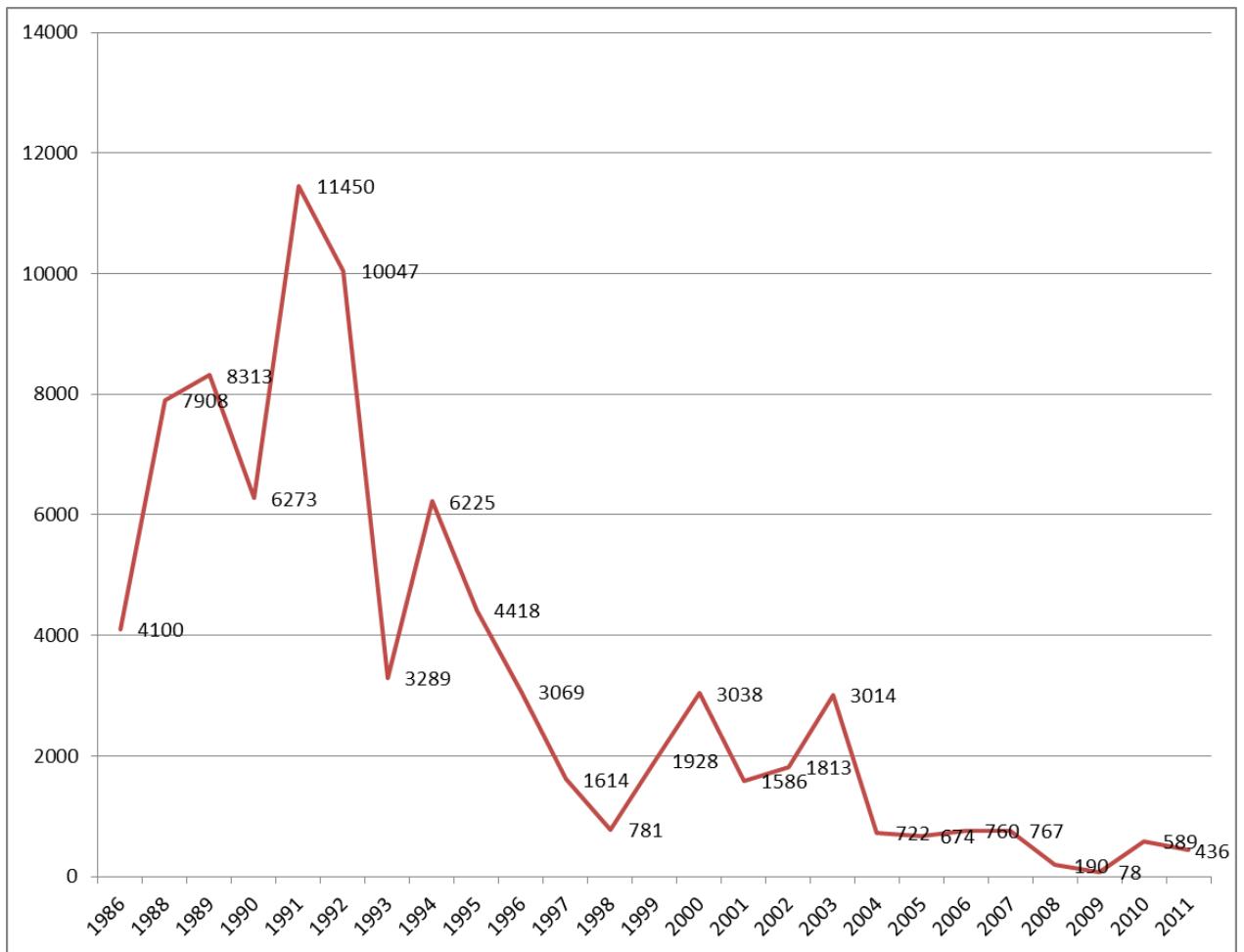


Table 3. Numbers of adult *C. puritana* and *C. dorsalis* within standard waypoint sections at all Calvert sites, 2004 to 2011.

Map	C. D. DORSALIS COUNTS								C. PURITANA COUNTS								Shoreline Notes	LAT	LON
Points	2011	2010	2009	2008	2007	2006	2005	2004	2011	2010	2009	2008	2007	2006	2005	2004			
Randle Cliff																			
1	0	0	0	0	0	0	0	0	7	9	0	7	0	0	0	0	public beach area, then cliffs begin; water level very high in 2005	4282206.00	366690.00
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	start main area of tall cliffs, very narrow, no beach	4282170.00	366700.00
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	same	4282169.00	366702.00
4	0	0	0	0	0	0	0	0	2	0	0	3	2	2	4	8	New breakdown area in 2005	4282063.00	366728.00
5	0	0	0	0	0	0	0	0	3	7	0	2	3	5	3	3	same, small sections of sandy beach	4281983.00	366763.00
6	0	0	0	0	0	0	0	0	7	0	0	0	0	0	18	0	same	4281923.00	366766.00
7	0	0	0	0	0	0	0	0	4	2	4	4	3	4	0	0	1-2 m wide, poor beach habitat; cliffs ok	4281870.00	366783.00
8	0	0	0	0	0	0	0	0	6	2	0	1	3	2	0	5	start breakdown with wider beach	4281857.00	366740.00
9	0	0	0	0	0	0	0	0	4	11	3	0	1	0	0	0	same but no beach; new sandy breakdown, mid height cliffs, dry	4281746.00	366806.00
10	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	8	wide, 3-4 m beach patch, then narrow; dry cliffs, small patch of beach	4281654.00	366832.00
11	0	0	0	0	0	0	0	0	0	0	0	1	4	1	2	3	narrow, no beach, even at mid-tide	4281501.00	366838.00
12	0	0	0	0	0	0	0	0	0	0	0	4	5	3	2	0	beach ends, no beach accessible to south, all v. narrow; breakdown at end	4281333.00	366857.00
	0	0	0	0	0	0	0	0	33	31	7	23	21	18	31	27			
Camp Roosevelt																			
13	0	0	0	0	0	0	0	0	ns	ns	0	0	0	0	0	0	Start at north end at stream entry, no cliffs then wood area, then tall dry cliffs		
14	0	0	0	0	0	0	0	0	ns	ns	0	0	0	0	0	0	South end of site		
	0	0	0	0	0	0	0	0	ns	ns	0	0	0	0	0	0			
Bayside Forest																			
15	0	0				0	0	0							0	0	N of BF, at Plum Point, at yellow house with lawn ornaments	4274428.23	368278.79
16	0	0				0	0	0							0	0	start series of white houses and no cliffs, some houses damaged by Isabel ?	4274050.32	368201.05
17	0	0				0	0	0							0	0	few small groins, cliffs fully vegetated, low, then wooded cliffs, trailer park	4273717.98	368134.07
18	0	0				0	0	0							0	0	creek, rock rip-rap, road bed to beach,	4273392.07	368107.36
19	0	0				0	0	0							0	0	start high cliffs, no suitable strata	4273246.13	368085.87
20	0	0				0	0	0							0	0	dry cliffs, most with vegetation	4272931.63	368026.85
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	cliffs end, marsh, creek entry, then woods, then low cliffs	4272475.73	367933.77
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	poor low, vegetated cliffs, breakdown; main survey area here to south+D61	4272131.05	367894.37
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	very tall cliffs, thin section of soft strata	4271673.71	367901.97
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	tall cliff section, narrow beach, many <i>C. repanda</i>	4271513.65	367901.33
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	pier posts in water, then no cliffs, then hard, marl cliffs	4271207.36	367883.21
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	cliffs dry, many fallen trees, then veg. cliffs	4270886.91	367855.87
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	same	4270884.91	367855.84
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	no cliffs, woods, then low cliffs; many <i>C. hirticollis</i>	4270696.80	367846.63
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	low cliffs, field behind, most cliffs bare, 20-25' high	4270437.65	367844.09
30	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3*	0	start cliffs, lots of trees down, equipment and tracks; many <i>C. hirticollis</i>	4270322.93	367847.95
31	0	0	0	0	0	0	0	0	24	17	1	5	9	3*	2	0	road access, no cliff section	4270138.63	367883.34
32	0	0	0	0	0	0	0	0	13	3	0	0	1	0	0	0	low bare cliffs, very wide beach (due to 2004 erosion)	4269824.88	367927.75
																	2009: wide beach, 10m, coarse sand and pebbles in ITZ over most of S cliff section of site		
33	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	Bayside Forest: south end access, low cliffs, evidence of severe erosion, cutback	4269741.77	367925.50
	0	0	0	0	0	0	0	0	37	20	1	5	14	6	2	0	*Note that these numbers were incorrectly placed further north in previous reports		
Warrior Rest																			
N of 33a	0	0	0	0	0			0	0	0	0	0	0	3	0	0	Cliff section north of Parker Creek mouth	4266573	367708
33a	0	0	0	0	0	0	0	0	0	11	0	0	0	3	12	0	Far N end, start at beginning of cliffs, S edge of beach (no waypoint)	4266344	367687
33b	0	0	0	0	0	0	0	0	89	5	11	17	55	182	0	0		4266059	367729
34	0	0	0	0	0	0	0	0	35	6	18	96	48	34	13	0	Near N. end, no access for last 300 meters of cliffs habitat, severe erosion	4266119.45	367764.62
35	0	0	0	0	0	0	0	0	105	27	25	133	111	275	44	0	Good cliffs	4265995.33	367799.37
36	0	0	0	0	0	0	0	0	290	190	133	341	160	394	47	0	same, creek entry	4265795.36	367829.99
37	0	0	0	0	0	0	0	0	202	79	74	131	88	222	7	0	good cliffs, narrow beach; 2 new small breakdown in 2009	4265649.67	367873.71
38-39	0	0	0	0	0	0	0	0	535	216	205	240	171	275	31	0	continue tall cliffs; some vegetated cliff sections; 2 new small breakdown in 2009	4265544.85	367896.40
	0	0	0	0	0	0	0	0	1256	534	466	958	633	1388	154	0	2009: many adults on low cliff face due to very high tides at low tide		
Scientists Cliffs																			
40	0	0	0	0	0	0	0	0	30	12	5	22	25	0	6	26	at creek entry and cove; last groin, tall cliffs begin	4265331.95	367963.69
41	0	0	0	0	0	0	0	0	39	0	0	0	0	5	0	2	narrow, no cliff habitat	4265159.36	367995.99
42	0	0	0	0	0	0	0	0	36	0	0	0	4	0	2	0	same, no cliff habitat, beach narrows	4264839.36	368062.58
43	0	0	0	0	0	0	0	0	8	0	0	9	56	60	2	2	wider beach 6-8 m; old or broken groins, end at creek entry, driveway to beach	4264568.17	368130.93
44	0	0	0	0	0	0	0	0	22	5	9	25	18	8	4	16	section of rip rap; same low, veg. cliffs	4264327.43	368210.95
45	0	0	0	0	0	0	0	0	34	4	11	55	4	12	11	20	same; new gabion in 2005	4264219.09	368244.75
46	0	0	0	0	0	0	0	0	0	2	6	13	8	1	0	6	continue groins, low or veg. cliffs	4263920.84	368332.12
47	0	0	0	0	0	0	0	0	4	0		11	10	9	0	0	same, groins	4263758.76	368380.74
48	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	20	6 groins, gabion, creek entry, low vegetated cliffs, ORV tracks	4263486.71	368474.83
49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	groins end, beach narrows; ORV tracks seen on beach in recent years	4263264.68	368571.49
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	SC North, S end, public beach, rock groin, 10-12 m wide beach; heavy beach use	4263137.40	368636.56
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	Start Scientist Cliffs South, beginning of north end, groins	4263127.00	368621.00
52	0	0	0	0	0	0	0	0	0	0	0	1	2	4	0	5	open face cliffs, groins; 3rd, 4th gabions	4262981.00	368641.00
53	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2	3	semi-vegetative cliffs, groins; most veg. cliffs	4262915.00	368665.00
54	0	0	0	0	0	0	0	0	0	0	0	3	3	19	9	8	semi-vegetative cliffs, end of groins; wide with breakdown bank	4262820.00	368708.00
55	0	0	0	0	0	0	0	0	4	0	0	7	16	18	16	12	open face cliffs (last groin at 8715)	4262758.00	368723.00
56	0	0	0	0	0	0	0	2	0	1	1	3	8	56	29	50	open face cliffs near waterline,	4262698.00	368749.00
57	0	0	0	0	0	0	0	0	3	2	7	34	34	18	12	12	same	4262638.00	368776.00
58	0	0	0	0	0	0	0	0	3	0	6	33	13	5	6	71	same, cliffs ending	4262564.00	368815.00
59	0	0	0	0	0	0	0	0	0	0	0	0	0			26	rock groin and residence, no open cliffs, far south end	4262435.00	368892.00
	0	0	0	0	0	0	0	2	0	183	26	45	218	206	213	111	280		

2009 Notes: nearly all groins are near fully submerged even now at low tide; breakdowns: 449(small); 448(med); 447(sg); 446 (lg); water levels very high

Calvert Cliffs State Park									C. dorsalis				C. puritana													
	2011	2010	2009	2008	2007	2006	2005	2004		2011	2010	2009	2008	2007	2006	2005	2004									
201	0	0	0	0	0	0	0	0		28	320	60	228	3	20	0		Farthest N that can be accessed, rocky shoreline, no beach, even at low tide	4252322	376584						
												38						N end of cliffs;		6630						
202	0	0	0	0	0	0	0	0		162	89	44	68	125	41	30		Here to north, very narrow, little beach habitat, but cliffs good	4251961	376687						
																		wider beach sections and good cliffs		6794						
																		start cliffs, no beach, inaccessible		6700						
203	0	0	0	0	0	0	0	0		56	280	215	318	23	9	0		marsh and beach section, no habitat	4251855	376794						
204	0	0	0	0	0	0	0	0		52	253	120	264	87	168	110		tall cliffs, tree rubble, narrow beach, then 4-5 m wide beach with most beetles	4251711	376896						
																		beach narrows, little or no width		6906						
205	0	0	0	0	0	0	0	0		50	23	0	97	0	28	70		trail accessing beach, very narrow beach, dry cliffs, then good top cliff area	4251569	376987						
206	0	0	0	0	0	0	0	0		0	0	12	46	5	8	0		marsh area and beach, no cliffs, no habitat	4251447	377087						
207	0	0	0	0	0	0	0	0		135	100	158	475	29	30	11		very narrow beach, excellent cliffs; new breakdown in 2009	4251334	377139						
208	0	0	0	0	0	0	0	0		44	30	15	67	7	8	10		arc beach, 0-1 m wide beach, then 2-3 m wide	4251150	377244						
209	0	0	0	0	0	0	0	0		45	7	4	46	13	26	11		mid, tall cliffs, good, 2-4 m wide beach, end at Rocky Point	4250975	377300						
210	0	0	0	0	0	0	0	0							0	0	0	south end of site, cliffs no beach								
	0	0	0	0	0	0	0	0		572	1102	666	1609	292	338	242										
Cove Point																										
120	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	Cove Point: start at north end, N of pier where beach starts; 2-3 m marsh behind	4250383.35	377646.58						
121	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	same	4250335.94	377706.05						
122	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	pier	4250264.84	377783.59						
123	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	narrow arc beach, with water behind	4250207.16	377810.49						
124	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	dense Phragmites behind, coarse sand, narrow beach, 0-2 m	4250130.76	377907.96						
125	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	GPS tube about 8 m offshore, phragmites on beach	4250072.66	377977.31						
126	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	narrow beach	4250005.28	378036.22						
127	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	beach wider, 1-2 m then widens to 5-7 m	4249958.70	378129.25						
128	0	0	0	0	0	0	0	3		8	0	0	0	0	0	0	0	wide beach, 6-10 m wide; still Phragmites behind	4249915.53	378260.68						
129	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	start first trees on back of beach; 8-12 m wide	4249879.53	378359.20						
130	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	same, beach wider	4249822.44	378523.70						
131	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	very wide beach, 20+ m	4249762.29	378699.79						
132	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	same, intertidal sand is soft	4249721.56	378854.50						
133	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	same	4249668.66	379073.50						
134	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	end at north end of lighthouse	4249605.74	379242.64						
	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0									

Table 4. New additional waypoint subsections with adult counts and shoreline notes for 2011. Includes new waypoints between existing standard waypoints at key sites.

	Nos.					
CCSP	C.pur	Coordinates	Shoreline Notes			
153	6	18 S 376567 4252174	North end, N of access, start cliffs	LITTLE COVE POINT		
154	13	18 S 376587 4252218	above to mini point	222	8	18 S 378217 4245898
155	9	18 S 376587 4252223	beach ends, no more access	223		18 S 378253 4245934
156	12	18 S 377325 4250894	Start now at Far S end, tree rubble, 15' do continue S	224		18 S 378273 4245958
157	33	18 S 377305 4250921	narrow bch, 1-2 m wide now at Low tide, end at Phrag	225	11	18 S 378319 4246014
158	6	18 S 377287 4250992	2-4 m wide, end at large rocky point	226	12	18 S 378331 4246035
159	4	18 S 377271 4251061	1 m to -1 m, all rocky ITZ	227	6	18 S 378357 4246068
160	34	18 S 377243 4251127	start lg arc bch 2 m -3m	228	3	18 S 378415 4246137
161	132	18 S 377218 4251157	continue same, end at small rock point	229	10	18 S 378431 4246158
162	3	18 S 377123 4251337	rocks and trees, end at 1st marsh beach=164	230	4	18 S 378461 4246199
165	50	18 S 376990 4251566	start cliffs, 2-3 m	231	0	18 S 378476 4246220
166	52	18 S 376906 4251665	same	232	5	18 S 378500 4246267
167	45	18 S 376825 4251782	same, end at second marsh beach	233	2	18 S 378527 4246312
168	11	18 S 376785 4251840	marsh beach, end at cliff start, all cp at N end	234	2	18 S 378542 4246373
170-71	162	18 S 376683 4251948	narrow rocky 1-3 m, end at access beach, near N end	235	3	18 S 378597 4246483
	572			236	6	18 S 378663 4246566
WARRIOR REST				237		18 S 378737 4246694
172-75	120	18 S 367910 4265479	go south to north, most all very narrow beach at LT 0-2m	238	4	18 S 378782 4246773
175	110	18 S 367898 4265480	All following points recorded with 100 individuals	239		18 S 378798 4246838
176	105	18 S 367899 4265518		240	4	18 S 378808 4246887
177	100	18 S 367887 4265534		241		18 S 378813 4246918
178	100	18 S 367879 4265574		242	1	18 S 378848 4246969
179	100	18 S 367869 4265593		243	2	18 S 378824 4247091
180	100	18 S 367837 4265710		244	5	18 S 378715 4247261
181	100	18 S 367820 4265767		245	5	18 S 378691 4247345
182	100	18 S 367816 4265815		246	18	18 S 378692 4247375
183	100	18 S 367805 4265852		249	8	18 S 378670 4247438
184	41	18 S 367789 4265968		250	26	18 S 378679 4247537
185	100	18 S 367789 4265993	very large new BD at 185	251	4	18 S 378642 4247622
186	80	18 S 367773 4266066	end survey, 100 m no beach section, return	253	31	18 S 378538 4247882
	1256			254	15	18 S 378539 4247895
SCIENTIST CLIFFS				total	195	
191		18 S 367892 4265564	Start good patch, north to south	WESTERN SHORES/CALVERT BEACH		
192	30	18 S 367898 4265509	new sm bd, south above, groin section	255		18 S 369573 4261025
193		18 S 367927 4265429	another sm bd with tree rubble	256		18 S 369626 4260886
194	39	18 S 367926 4265404	around point here, no more S of here, no bch or cliffs	257		18 S 369644 4260839
195	36	18 S 367932 4265347	outcrop and bare cliffs	262-3		18 S 369771 4260592
196		18 S 367992 4265158	very lg bd and extensive tree rubble, from last year	264		18 S 369803 4260546
197	3	18 S 368008 4265067	no habitat	267		18 S 369910 4260325
198	5	18 S 368067 4264866	no cliffs	269		18 S 369990 4260189
199	18	18 S 368125 4264592	sm bare, good cliff patch	271		18 S 370083 4260055
200	4	18 S 368133 4264553	another sm bd just to south	272		18 S 370147 4259944
201	34	18 S 368215 4264312	nice outcrop, 40 m long	273		18 S 370187 4259878
202	4	18 S 368378 4263731	wide beach little cliff habitat	274	15	18 S 370226 4259815
201	4	18 S 368732 4262785	SC south, 3 photos of cliffs in groin area	275	11	18 S 370281 4259760
204	3	18 S 368773 4262660		276	8	18 S 370290 4259729
205	3	18 S 368821 4262551	near south end, end survey at 1:30	277	0	18 S 370330 4259686
	183			279	0	18 S 370440 4259586
CLIFFS OF CALVERT				281	19	18 S 370555 4259460
206		18 S 376954 4244215	rock pile at start, south end	282	17	18 S 370618 4259395
207	2	18 S 377003 4244281	new bd=breakdown	283	13	18 S 370692 4259332
208	6	18 S 377028 4244325	continuous slump from 207 to 212, excell cliffs	284	9	18 S 370758 4259261
211	4	18 S 377155 4244507	repanda moderately abundant and consistent	285	18	18 S 370786 4259237
212	6	18 S 377172 4244537	along COC and LCP today		110	
214	1	18 S 377318 4244756	rockpile			
215		18 S 377343 4244781	bd			
216	8	18 S 377430 4244892	70 m long slump			
217	0	18 S 377718 4245288	rockpile, N end of marsh			
218	8	18 S 377794 4245416				
219	12	18 S 377811 4245438				
220		18 S 377854 4245473	S end of revetment			
221		18 S 377895 4245504	N end revetment, no beetles behind			
	47					

Summary of *C. puritana* Trends at Sassafras River Sites, 1989 to 2011. The results of annual surveys at all sites produced a total count of 1514 adults in 2011 compared to 2615 adults in 2010, the latter count the second highest we ever recorded. Other recent counts of 837 in 2009, 1770 in 2008, 1221 in 2006, and 1566 in 2007 indicate high and sustained counts for the past five years and a significant recovery from consistent low counts from the late 1990s to 2005 (Fig. 3, Table 5). The decline from 2010 to 2011 was a result of significant declines in the three largest sites, Grove Point declined from 1322 to 750, West Turner from 589 to 203 and East Lloyd from 559 to 249. The lowest of recent counts in 2009 would likely have been higher if not for the unusually high tides at some of the survey sites. Although counts were done several hours after high tide, water levels were higher than I recall during any previous surveys. For example, at Grove Point there was cliff breakdown in several sections as the survey was being made.

It is important to note this pattern of abundance over the years parallels the pattern of the Calvert metapopulation. The causes of these similar patterns of abundance in the Sassafras and Calvert metapopulations are unknown as are those factors that caused the significant decline from 1996 to 2005. We have hypothesized that a progressive increase in bluff vegetation occurred during this period and reduced habitat quality, especially for recruitment and larval development. The cliff vegetation and especially that along the back beach and base of the cliffs could have reduced the amount of adult foraging habitat and restricted their movement to suitable oviposition sites on the cliff faces. It may also be that the composition of the vegetation on the cliffs is changing to more invasive species that are more resistant to erosion and/ or more effective in stabilizing the cliff faces. Shoreline and bluff erosion from Hurricane Isabel in 2003 could have countered this trend and reduced cliff face and base vegetation. Consequently, larval habitat improved, recruitment increased and populations of adults began to increase after this time. Because of the two year life cycle of *C. puritana* the improved conditions would take several years to be realized. Other lesser known storms and shoreline events also continue to cause localized erosion, cliff breakdown, etc. and these can complicate the understanding of population fluctuations.

The above hypothesis is uncertain and the effects of vegetation changes may be better understood after additional years of results from the vegetation removal study being done at West Turner and East Lloyd (see below). It is also possible that other factors may be involved or more important. Density dependent factors and inherent population dynamics, parasitism or competition from co-occurring species (*C. repanda*) could also be driving some of the changes. Habitat studies at Sassafras in 2008 indicated larvae of both *C. repanda* and *C. puritana* were present in the same bluff microhabitats. Larvae of *C. repanda* were at high densities in low cliff faces during early to mid-summer where adults of *C. puritana* were ovipositing and when their larvae developing in late summer into fall. This co-occurrence could have a strong competitive impact (food availability) on adult *C. puritana* and early instar larvae. Adults of *C. puritana* could also be preyed upon by *C. repanda* on these cliff faces.

Summary Results for Individual Sassafras Sites. Adult counts within the same standard waypoint sections for each of the Sassafras sites 2004-2011 are given in Table 6 along with shoreline characteristics for each section of shoreline. The adult population at Grove Point has consistently been the largest population of the Sassafras sites and in many years accounting for more than half of the Sassafras metapopulation total. The count for Grove Point in 2011 was 750 in 2011, a significant decline from the 1322 in 2010. Other recent counts were 347 in 2009, 986 in 2008 and 843 in 2007, indicating a significant increase in this population since the very low counts from 1999 to 2005. Numbers at this site declined after 1996-1997 to a low of 78 in 2002 and remained at less than 300 adults until 2006. As in most recent years the main concentration of adults was from waypoints 61 to 64 where the best combination of beach and especially excellent cliff habitat was present. Few or no adults were found at the east and northwest ends of the site. Limited changes in the site were noted in the form of two new breakdowns in the adult concentration area.

Numbers at Ordinary Point increased to 75 in 2011 from 24 in 2010 which was the lowest count in the past four years. It compares with 41 in 2009, 100 adults in 2008, and 53 in 2007. Most adults were concentrated near the north end of the site as in other recent years. Counts at this site were much higher in the mid-1990's, peaking at 215 in 1992. This site includes a long section of shoreline but only limited sections of suitable cliff habitat because much has significant vegetation growth on the cliffs. Another factor is the very little wide beach which reduces overall habitat suitability. This site might be suitable for vegetation removal or management since the substrate seems otherwise suitable were it not for vegetation cover.

North Still Pond had a count of 70 in 2011, up from 54 in 2010, the lowest count in the past five years. Higher recent counts were 99 in 2009 and 120 in 2008. Numbers at this site have been more stable than most sites, with counts ranging from over 60 to 150 in most years. There seemed to be little apparent change in the cliffs or shoreline at this site, except for a slight increase in vegetation in some sections. Adults were present along most of the length of the site. One negative feature seems to be the orientation of the beach and cliffs which are shaded much of the day. Some sections of the cliffs have been quite heavily vegetated or rocky and seemingly suboptimum as larval habitat.

The numbers at East Betterton and West Betterton have increased significantly in recent years, continuing relatively high counts again in 2011 with 52 in East Betterton and 112 at West Betterton (this the highest count since 126 in 2003). Counts in 2010 were 67 at West Betterton and 59 at East Betterton. The 59 at East Betterton is the highest ever count at this site. In 2009, numbers declined to levels similar to the mean numbers in the past 10 years, 15 at East Betterton and 55 at West Betterton. The consistently low numbers at East Betterton can be explained by cliffs that are heavily vegetated along most of the length of the site and thus with little breeding habitat. Several open cliff patches (waypoints 34, 35, 180) in 2010 and 2011 supported nearly all of the adults. West Betterton has had much higher counts peaking at near or over 200 in the 1990's. At this site nearly all adults have been concentrated within waypoints 37-42 where there are a few sections of bare cliffs. Vegetation on the cliffs may have reduced habitat

suitability in most recent years, but this was not obvious from our surveys. It is similar to East Betterton in shoreline and cliff characteristics, but includes a much longer length of shoreline and is heavily vegetated or with gravelly or clay soils.

East Turner Creek. The 2011 count here was 3 adults compared to the recent high count of 32 in 2010. This site has been marginal over the past 15 years. The site had no adults in 2009, 3 in 2008 and none in 2007, and has supported few or no adults in since 1996 except for high counts of 35 in 2005 and 20 in 2006. The site has experienced increased vegetation growth on the cliffs, possibly a result of the pier and breakwater constructed at the west end of the site in the early 1990's. The beach is also narrow along most of the length. In 2010 the adults were at the west end of the site where there was evidence of recent breakdown and a bare cliff section.

Two adjacent sites on the south shoreline of the Sassafras that have experienced significant changes in numbers in the past five years are East Lloyd and West Turner Creek. These sites are part of experimental study of the effect of vegetation removal on the *C. puritana* population, with each site having a cliff section where vegetation was removed and a paired control section of cliff. Details of the 5 individual cliff sections in this study are discussed in the following section of this report. East Lloyd had 249 in 2011 which is a significant decline from the 559 in 2010. Numbers at this site have been low, typically about or less than 100 adults from 1993 to 2005, before a major surge to 554 in 2006, followed by a decline to 368 in 2007, 136 in 2008, and 115 in 2009. This site included both a control cliff (E) which had 121 adults in 2011 (205 in 2010) and a vegetation removal cliff which had 124 in 2011 (254 in 2010). Observations suggest the declines in 2008 and 2009 may have been the result of significant cliff breakdown and erosion which seem more prevalent at this site than others in the area. This in turn could have led to significant recruitment and large numbers in 2010. Of interest it that cliff section D of East Lloyd, a vegetation removal site, has had consistently higher counts in the past 4 years following vegetation removal, while the control site, cliff E has not shown the progressive increase (see below).

Numbers at West Turner, which also included a vegetation removal section (cliff A) and a control site (cliff B), had a count of 203 in 2011 compared to 469 in 2010. This site experienced a dramatic and progressive increase from 2004 to 2008 (3 in 2004, 18 in 2005, 172 in 2006, 218 in 2007, 296 in 2008) before a decline to 165 in 2009. Population changes from 2007 to 2009 continued significantly higher and could have resulted from improved habitat quality from vegetation removal. Interpretation of results of the vegetation removal study are complicated by the many factors, including many unknown, that could affect population dynamics of this species. For example all Sassafras populations declined throughout the mid 1990s and reached lows in 2005, then experienced significant and progressive increase, peaking at most sites in 2008 and even higher in 2010.

Table 5. Total index counts of *C. puritana* at all Sassafras sites, 1989-2011.

Sites	1989	1991	1992	1993	1994	1995	1996	1997	1999	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Grove Point		1000+	1667	750	567	920	1230	452	150	78	195	254	90(156)	273	843	986	347	1322	750
Ordinary Point	650	12	215	88	110	208	78	45	120	0	9	40	28	30	53	100	41	24	75
North Stillpond.			217	190	87	133	138	92	44	220	119	42	26	143	66	120	99	54	70
W. Betterton		79	281	234	160	210	131	78	64	69	126	34	52	23	6	92	55	66	112
E. Betterton		0	20	19	40	44	21	28	7	11	16	6	12	6	12	34	15	59	52
East Lloyd		9	205	139	15	94	118	30	16	8	160	11	96(73)	554	368	139	115	559	249
West Turner	150	0	51	12	47	88	80	19	10	12	3	3	18(4)	172	218	296	165	589	203
East Turner	150	7	99	20	0	68	25	0	ns	2	2	8	35	20	0	3	0	32	3
Totals	950	1107+	2755	1452	1026	1765	1821	744	411	400	630	398	153	1221	1566	1770	837	2705	1514

Fig. 3. Total index counts of *C. puritana* at all Sassafras sites combined, 1989 to 2011.

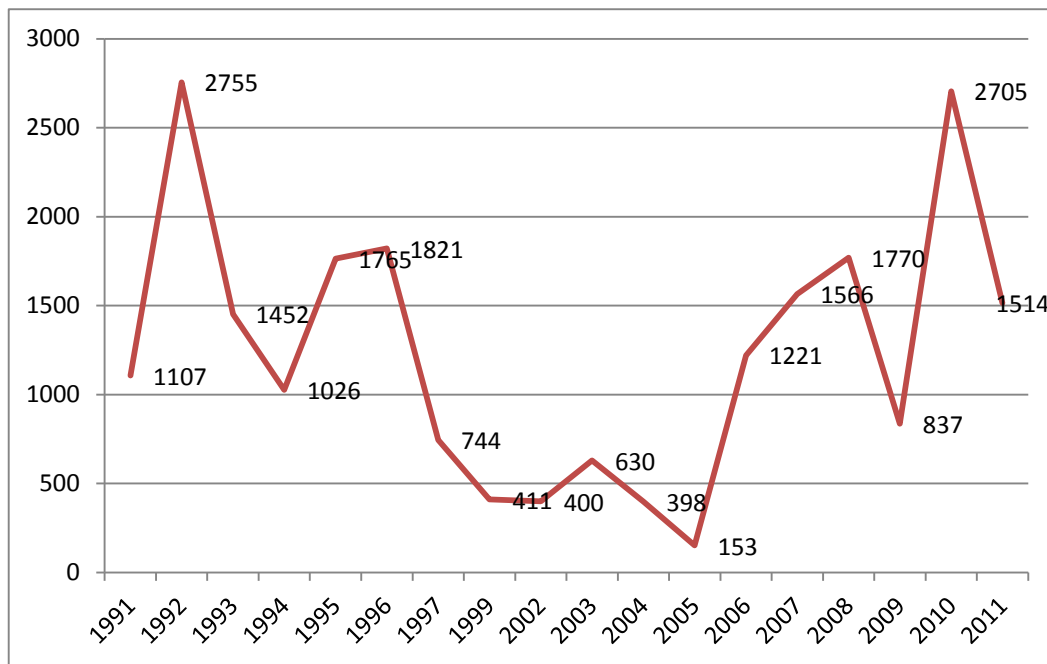


Table 6. Numbers of adults and shoreline characteristics at waypoint sections of all Sassafras sites, 1989 to 2011.

Map Pt.	2011	2010	2009	2008	2007	2006	2005	2004	Latitude	Longitude	Shoreline Characteristics
Cabin John											
start	5								417869.00	4368885.00	narrow beach, limited cliff habitat
end									417812.00	4368830.00	
Grove Point											
057	0	0		0	0	0	0	0	4360277.00	410540.00	E end of site; dry cliffs, sand and some pebbles//very dry cliffs, 6-7 m beach, all bare
058	3	3	0	3	0	0	0	0	4360333.00	410498.00	very rocky, no beach, -1 m wide, cliffs vegetated//gets rocky, then trees;
059	33	12	4	11	7	3	5	4	4360415.00	410410.00	wider beach, good cliffs, 1 m, then tree rubble//wide beach, 6 m, ok cliffs
060	22	48	33	93	25	11	2	1	4360515.00	410374.00	narrow, -1 m wide, very good cliffs, then 1 m wide
061	165	166	44	169	143	39	7	15	4360577.00	410341.00	good cliffs, 1 m wide beach, earlier this was best prime section; cliff breakdown in 2009
062	87	96	41	113	111	92	14	0	4360639.00	410327.00	start pebble and stone beach, very narrow, cliffs veg., no habitat
063	50	161	125	353	166	81	61	146	4360695.00	410328.00	start good cliffs, 0-1 m wide, previously good, beach narrow; massive cliff
	60	171			78				60761	10334	breakdown in 2009
	155	196			139				60808	10339	
064	75	220	72	123	59	18	39	29	4360888.00	410361.00	good cliffs, same beach but then narrows// southern half very good sand beach and
065	19	176	21	47	49	11	7	18	4360950.00	410368.00	good cliffs but pebble, rocky beach, 1 m wide/still good cliffs
066	18	27	0	6	6	0	0	6	4361051.00	410387.00	very rocky, good cliffs end, then vegetated and non-habitat, road enters shoreline
067	11	7	0	6	12	0	0	12	4361138.00	410403.00	start N of road, narrow beach, 0-1 m, good upper cliffs
068	12	4	8	12	8	12	3	6	4361270.00	410472.00	same, some ok cliffs, 0 m beach
069	0	6	0	0	0	3	0	0	4361359.00	410507.00	low cliffs, no beach, -2 m wide
	6								4361384	410506	south end of new revetment; all logs and sticks behind revetment in 2007
070	0	24	0	0		0	18	8	4361401.00	410527.00	start bare cliffs, newly eroded, narrow beach/same
	0				38				4361427	410545	N end of revetment
071	5	9	0	0	0	0	0	0	4361506.00	410594.00	cliffs are ok habitat, beach ok, cliffs end, no habitat
072	0	0	0	0	0	0	0	3	4361552.00	410622.00	start low cliffs, ok habitat
073	6	11	0	0	2	0	0	0	4361586.00	410642.00	continue low, no cliffs
195	20	0	0	0	0	0	0	0	4362115.00	411315.00	Grove Neck, north end; gray clay, 12 m high then lower
196	3	0	0	0		0	0	0	4362060.00	411170.00	very rocky with many trees down/metal stakes; photo looking south, pier at top
197	0	0	0	0		0	0	1	4361936.00	410939.00	gray clay then red sand and rock; large sand stones on beach
198	0	6	0	0		3	0	5	4361720.00	410734.00	gray clay, 12 m high, then red sand top, very rocky beach
199	0	0	0	0		0	0		4361586.00	410647.00	end, meet bk
	750	1343	347	986	843	273	156	254			
North Grove Point											
074	0	0	0	n	n	no	0	0	4362490.00	412209.00	rocky with sand, 1.5 m low dry cliffs, tree rubble
075	0	0	0	n	n	survey	0	0	4362446.00	412101.00	red sand cliffs at top, bare, ok habitat
076	0	8	0	n	n	in	0	0	4362392.00	411990.00	all clay cliffs, no habitat
077	0	0	0	n	n	2006	0	0	4362371.00	411945.00	end, meet jim, photo
200	0	0	0	n	n		0	45	4362317.00	411799.00	rocky beach, trees down; going N, new site, north of 200
201	0	0	0	n	n		0	0	4362368.00	411938.00	end site
	0	8					0	45			
Ordinary Point											
083	0	0	0	0	0	0	0	3	4359852.00	414418.00	Ordinary Pt. West, N end, dry stoney cliffs, 0-1 m wide
084	11	7	11	15	10	2	1	0	4359810.00	414442.00	good cliffs, no beach, then rocky cliffs, fully vegetated, tree rubble
085	17	9	21	33	0	5	15	22	4359753.00	414538.00	good cliffs, tree rubble, narrow beach, sandy
086	33	6	9	24	40	23	12	12	4359726.00	414570.00	breakdown, then ok cliffs, sandy 1 m wide
087	10	2	0	22	0	0	0	0	4359669.00	414655.00	end habitat
088	0	0	0	0	3	0	0	0	4359558.00	414922.00	continue Ordinary, N end, veg cliffs narrow to no beach, all tree rubble
089	4	0	0	0	0	0	0	3	4359508.00	414970.00	1 m beach and very veg. cliffs
090	0	0	0	0	0	0	0	0	4359464.00	415011.00	same
091	0	0	0	0	0	0	0	0	4359385.00	415062.00	same, end site
207	0	0	0	0	0	0	0	0	4359309.00	415117.00	variable beach width
208	0	0	0	0	0	0	0	0	4359384.00	415061.00	end of site
	75	24	41	100	53	30	28	40			
Map Pt.											
East Turner											
024	0	0	0	3	0	0	3	0	4357503.00	415759.00	East Turner Ck.; 0 m wide beach, tree rubble, good cliffs
025	3	0	0	0	0	0	1	0	4357525.00	415813.00	same
026	0	0	0	0	0	0	0	5	4357535.00	415831.00	same, good cliffs
027	0	20	0	0	0	17	30	0	4357556.00	415861.00	1 m beach width, cliffs low and very vegetated
028	0	12	0	0	0	3	1	3	4357587.00	415906.00	
029	0	0	0	0	0	0	0	0	4357627.00	415961.00	end at breakwater, shaded; photos 1, 2
	3	32	0	3	0	20	35	8			

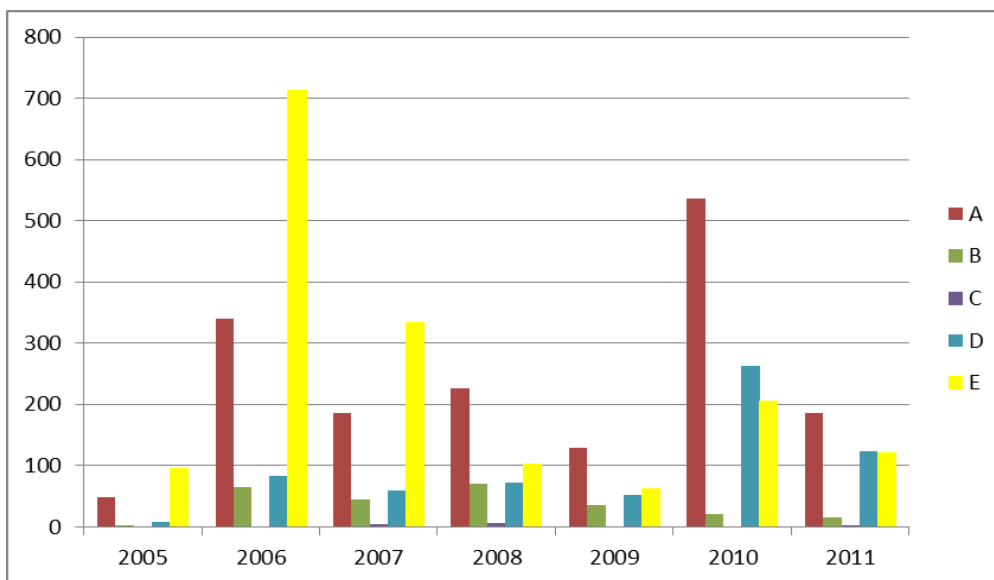
West Turner											
082	16	153	35	71	45	104	8	0	4357964.00	413531.00	West end of site; gravelly beach, many small trees down
206	69	230	90	155	152	68	18	3	4358153.00	413887.00	many downed trees, many larvae in fall down (repanda?); Section A
205	118	86	40	67	21	0	0	0	4358284.00	414014.00	east end of site
	203	469	165	293	218	172	26	3			
East Lloyd											
078	15	101	29	67	35	347	44	8	4357434.00	411911.00	West Lloyd, photo; west end, good bare cliffs, no beach-Section E, Control Site
079	88	88	22	16	28	134	12	0	4357448.00	411987.00	narrows, -1 and rocky, but cliffs ok
080	12	16	12	25	245	10	3	0	4357486.00	412089.00	sandy narrow beach
081	6	0	0	3	10	0	3	0	4357490.00	412105.00	end site
202	2	51	14	13	10	0	0	0	4357668.00	412477.00	W. side of E. Turner Ck. Narrow beach, red sand, small stones; Section D
203	115	213	38	55	40	63	11	3	4357747.00	412613.00	no beach, many downed trees; all red sand bluff
204	11					0			4357856.00	412706.00	trees down up river; end at end of bluff
										2896	
	249	559	115	179	368	554	73	11			
East Betterton											
030	0	2	0	0	0	0	0	0	4358265.00	410113.00	East Betterton, east end at pier, no cliffs
031	0	0	0	0	0	0	2	2	4358264.00	410087.00	low cliffs, very vegetated, 1 m wide
032	0	0	0	1	0	0	1	2	4358270.00	410046.00	heavy tree rubble, some bare cliffs
033	1	2	0	0	0	0	0	0	4358301.00	409969.00	all very narrow beach, 0 m wide; bank swallows
034	10	13	4	11	1	0	0	0	4358332.00	409866.00	start good cliffs but no beach, tree rubble
035	21	22	5	10	3	3	3	0	4358328.00	409755.00	end of survey, meet jim from west
180	20	20	6	12	8	3	6	2	4358366.00	409583.00	E. Betterton, start at W. end (bk east end)
181	0	0	0	0	0	0	0	0	4358367.00	409583.00	
182	0	0	0	0	0	0	0	0	4358330.00	409753.00	meet bk
	52	59	15	34	12	6	12	6			
West Betterton											
036	0	10	0	2	0	0	2	6	4358536.00	407647.00	start east end, very good cliffs, 2 m wide
					0				4358534	407636	W end of revetment
037	18	12	1	17	0	0	12	10	4358535.00	407604.00	very good cliffs, 2 m wide
038	45	12	13	25	0	3	10	6	4358540.00	407511.00	continue same, 1-2 m wide beach
039	29	18	20	17	0	8	11	8	4358544.00	407433.00	point, tree and cliff breakdown, no beach, major cliff recession
040	14	2	8	10	0	0	17	0	4358516.00	407367.00	beach wider but fully tree covered
041	0	0	2	0	0	11	0	2	4358504.00	407279.00	bare cliffs and breakdown
042	6	16	2	21	0	0	0	0	4358503.00	407265.00	end, meet Jim from west
043	0	0	0	0	6	0	0	0	4358504.00	407264.00	
183	0	6	9	0	0	1	0	1	4358444.00	406876.00	West Betterton; heavily veg. west end, east end more open
044	0	0	0	0	0	0	0	0	4358426.00	406418.00	W of West Betterton; very extensive riprap, east end, no cliffs, trees
045	0	1	0	0	0	0	0	0	4358428.00	406330.00	tall mostly vegetated cliffs, non-habitat; 1 m beach
046	0	0	0	0	0	0	0	0	4358447.00	406121.00	Tall, part bare cliffs, 1-2 m each, then continue poor habitat
047	0	0	0	0	0	0	0	0	4358459.00	406039.00	cliffs low and most vegetated
048	0	0	0	0	0	0	0	0	4358464.00	405987.00	start 50 m rip rap section
049	0	0	0	0	0	0	0	0	4358475.00	405923.00	end rip rap but no habitat
050	0	0	0	0	0	0	0	0	4358510.00	405748.00	same, no habitat
051	0	0	0	0	0	0	0	0	4358555.00	405528.00	same, no habitat
052	0	0	0	0	0	0	0	0	4358594.00	405289.00	end
186	0	0	0	0	0	0	0	1	4358638.00	404891.00	Scout camp, go west to east, bk east to west; cliffs stabilized, trees
187	0	0	0	0	0	0	0	0	4358616.00	405186.00	many trees on bluffs
188	0	0	0	0	0	0	0	0	4358606.00	405286.00	end, meet bk
	112	66	55	92	6	23	52	34			
North Still Pond											
189	0	0	0	0	0	0	0	0	4355728.00	402057.00	S end of Still Pond; rip rap area; then wider beach, many trees
190	10	17	42	55	12	10	2	14	4355825.00	402055.00	gully, many hirticollis larvae; start eroded bluff, rocky
191	30	13	20	25	4	28	7	14	4356068.00	402093.00	rocky, recent erosion on bluff, hardened sandstone
192	16	11	25	34	24	50	17	11	4356301.00	402194.00	ending bluff, beach 3-5 m wide
193	6	12	12	6	18	44	0	3	4356546.00	402428.00	end bluff, beach 3-5 m wide
194	8		0	0	8	11			4356587.00	402565.00	end
	70	54	99	120	66	143	26	42			
Southwest of Still Pond											
053			0	ns		no	no	0	4354661.00	400298.00	New site; G80rock, pebble on much of beach; 25-30' cliffs
054			0			survey	survey	0	4354657.00	400370.00	same, rubble at base, 0-1 m wide, cliffs rocky
055			0			in	in	0	4354663.00	400496.00	more rocky cliffs
056	ns	ns	0			2006	2005	0	4354649.00	400586.00	no habitat, rocky cliffs, end
Totals											
		2515	837	1770	1566	1221	458	398			

Summary Results of Vegetation Control Study at Sassafras WMA The experimental vegetation removal study at the Sassafras Wildlife Management Area included 5 separate cliff areas; at two of these cliffs sections (A and D) vegetation was removed using herbicides in 2008 while three other cliff sections (B,C, E) were left as controls. Herbicide treatment was carried out in August 2006 after the adult activity period. Conclusive results in this study will be difficult to determine because of the many factors that affect the population dynamics of this species (as with other tiger beetles) and the pattern of erratic fluctuations of adult numbers from year-to-year. In addition, practical limitations of the study did not allow for an experimental design suitable for appropriate statistical analysis. For example, all sections except C had a very significant increase in adult numbers from 2005 to 2006 during the summer before the fall removal and significant declines at all sites in 2009. (Fig. 4). But, now with 5 years of post-removal counts, there does appear to be some evidence of a positive effect of the removal. Means of adult counts for the experimental removal sites (A and D) increased from 241 adults before the removal to 368 after removal while control sites (B,C, E) decreased from a mean count of 440 adults before removal to 204 after removal (Table 7).

Table 7. Comparison of adult counts in removal and control groups in the vegetation removal study before (2005-2006) and after (2007-2011) removal.

	MEANS			TOTALS	
	2005-06	2007-11		2005-06	2007-11
Removal (A+D)	241	368		482	879
Control (B,C,E)	440	205		879	1027

Fig. 4. Maximum counts of *C. puritana* adults at the vegetation control study along the south shore of the Sassafras River (East Lloyd and West Turner sites), 2005 to 2011. Counts in 2005 and 2006 are pre-treatment, 2007-2011 are post treatment.



New Survey Sites for *C. puritana*. A new site surveyed in 2011 was the Grove Farms Wildlife Management Area along the north shore of the Sassafras River east of Grove Neck. This is a potential tranlocation or vegetation removal site. Survey results indicated no *C. puritana* were present at this site; 84 *C. repanda*, 4 *C. hirticollis* and 2 *C. punctulata*. We found. We do not include a map of this area but the waypoints are as follows: start at 39.38500, 76.00570 and end at 39.38.507, 75.99922.

Surveys for *Cicindela dorsalis dorsalis* on Janes and Cedar Islands. These two sites on Maryland's Eastern Shore have had the two largest populations of *C. d. dorsalis* in Maryland in recent years. They are at the northern end of the species range within the Chesapeake Bay, both relatively isolated from Virginia sites, with long lengths of shoreline and not affected by human related impacts. The adult counts for the standard waypoint sections for 2011 and previous years' numbers along with relevant shoreline sections are given in Table 8. Topographic maps are included in the Appendix of this report. **The total number of adult *C. d. dorsalis* counted at Janes Island was 1087 in 2011 compared to 1163 in 2010 and 1330 in 2009, and 3081 in 2006.** The highest count was 6094 in 2002 and the lowest was 369 in 2004. The distribution in all years have been generally similar with adults present along much of the shoreline, but most in the middle section of the island, waypoints 19-32 and another concentration in the northern end of the site, waypoints 1-12. In summary, this site has to date a large and viable population.

The **2011 adult count at Cedar Island was 1691 adults compared with 1439 in 2010, 974 in 2009 and 2454 in 2006.** Numbers at this site have ranged from 669 in 1997 to 2464 in 2002. The distribution pattern has been similar in most years, with adults widely distributed throughout the site but especially abundant in the southern half of the site. *Cicindela hirticollis* and *C. marginata* have also been common at this site. Like Janes Island, this site has a maintained a large and viable population of *C. dorsalis*.

	<u>1997</u>	<u>1998</u>	<u>2002</u>	<u>2004</u>	<u>2005</u>	<u>2006</u>	<u>2009</u>	<u>2010</u>	<u>2011</u>
Janes Island	938	1991	6094	369	2475	3081	1330	1163	1087
Cedar Island	669	1495	2464	1095	1298	2454	974	1439	1691

Table 8. Numbers of adults of *C. dorsalis* at Janes and Cedar Islands, 2002-2011.

Waypt	2011	2010	2009	2005	2004	2002	Shoreline Characteristics		
1	22	50	17	18	48		Far NE tip; unveg. 12-40 m wide spit w/some mudflats; little wrack; most Cdd on N side of spit; spit narrows	38.0312170	-75.8461330
2	3	7	17	52	15		10-16 m wide beach w/25-40% covered by thick wrack; 3-5% with <i>Sp.alterniflora</i> .	38.0331500	-75.8473170
3	22	32	20	33	17		8-12 m wide sand beach w/10-15% wrack cover and no <i>S. alterniflora</i> . Coarser sand.	38.0345000	-75.8479000
4	68	57	36	30	19	585	10-20 m wide beach w/20% wrack cover, mouth of Thru Creek.	38.0365170	-75.8509830
5	70	96	65	67			mouth of small tidal creek	38.0377500	-75.8544170
6	8	0	83	1		11	same	38.0271670	-75.8704000
7	0	8	8	42		180	narrow beach, marginal habitat, some wrack	38.0269830	-75.8722170
8	33	9	82	112			beach widens, good habitat section	38.0273500	-75.8741000
9	197	217	12	279			same	38.0260500	-75.8667170
10	88	66	82	26			wide beach, 3-5 m	38.0242500	-75.8671170
11	19	0	91	0		258	N of Rock Hole, wide beach, good habitat	38.0225830	-75.8682830
12	30	16	25	60		880	same	38.0216000	-75.8683670
13	61	101	40	57	46		NW corner of small bay	38.0203670	-75.8701170
14	0	13	39	4	1		E shore of Rock Hole; all Cdd concent. in 30-40 m section; 12-20 m sandy; little Cdd habitat elsewhere	38.0170500	-75.8718670
15	0	3	20	18	12		E shore Rock Hole; steep narrow beaches with wrack shores; little or no beach; all Cdd conc at creek outlet.	37.9700500	-75.8900500
16	0	0	4	0			Series of short wide, 20-30 m sand beaches w/intervening <i>S. alterniflora</i> line beaches and mud flats.	37.9716670	-75.8912500
17	7	0	0	0	6		Began at small creek outlet; 15-40 m wide by 70-80 m long.	37.9725170	-75.8935500
18	8	0	0	0		130	Little sand beach; most shoreline bordered by <i>S. alterniflora</i> , thick wrack w/5-15 m wide beach behind	37.9737	75.897017
19	9	5	0	15			Nice long (200-300 m) beach w/well developed foredune but few Cdd; section ends at picnic area	37.975067	75.897917
20	30	55	8	456		280	most narrow beach.	37.976567	75.896567
21	37	38	49	280			long section of marsh beach, wide 3-5+ m	37.979767	75.894333
22	37	11	57	74		304	similar good habitat	37.98385	75.890883
23	28	40	47	58			same	37.98575	75.889633
24	0	123	168	119			sandy marsh beach, 3-6 m wide; good habitat	37.98885	75.887767
25	29	0	0	12		1822	beach narrows	37.991417	75.886917
26	96	0	0	81		440	marsh behind beach	37.9942	75.8862
27	60	66	87	188			Creek outlet	37.9921	75.8866
28	89	78	0	292	72		Stumps in intertidal	37.9914	75.8869
29	22	11	53	57	86		Green buoy	37.9888	75.8878
30	2	0	0	37	27		end of section;.	37.9857	75.8896
31	12	0	112			718	good Cdd habitat.	37.9838	75.8909
32	0	0	0	7	9		good Cdd habitat. Most w/30-100 m long sections of 8-12 m wide sandy beach w/30% wrack cover.	37.9798	75.8943
33	0	0	0	0	2		Half of section w/5-10 m wide beaches; wrack w/narrow, 2-6 m wide coarse beach	37.9766	75.8966
34	0	51	72	0		177	small sections of 10-15 m wide sandy beach but most (70-80%) of shoreline bordered by tump and wrack.	37.9751	75.8979
35	0	0	17	0			began at small pt ~100 m N shoreline bordered by <i>S. alterniflora</i> w/narrow coarse sandy beach behind it.	37.9737	75.897
36	0	0	3	0	2		N of SW tip, no suitable habitat. Much beach covered by wrack.	37.9725	75.8936
37	0	0	4		2		4th rock groin; 40-50% shoreline armored by large rock; 10-18 m wide sand beach w/30-50% wrack cover.	37.9717	75.8912
38	0	0	0			309	at 3rd rock groin. 10-15 m wide sand beach w/10-20% wrack cover. No foredune behind beach.	37.97	75.8901
39	0	2	0		5		Began at 2nd rock groin. 10-15 m wide sand beach w/30% wrack cover.	37.9723	75.8835
40	0	8	12				S end of Island; House Cove and started at large rock groin; 10-15 m wide beach w/30% wrack	37.9697	75.8781
	1087	1163	1330	2475	369	6094			
	2011	2010	2009	2005	2004	2002			
1	9	30	7		25		spit on south side	37.9537	75.889433
2	11	12	16	22		318	wrack on beach, 0-3 m wide	37.951433	75.889667
3	15	29	14	103	33	203	same, beach widens, much wrack on beach	37.949917	75.8904
4	57	61	79	144	35		start open sand spit, some veg.	37.947233	75.89055
5	144	176	43	71	18	368	west end, wide beach and open sand spit	37.94555	75.89005
6	35	17	26	107	86	533	begin peat area, wide beach, 30% wrack cover	37.942917	75.8913
7	29	95	62	5	70		good habitat; long 10-15 m wide sandy beach w/30% wrack cover and well developed foredune.	37.941517	75.8919
8	202	252		214	185	208	same, beach widens, much wrack on beach		
9	288	336	454	244	354	746	good habitat; most wide (10-15 m) beach w/20-30% wrack cover w/intervening sections of wrack shorelines.	37.92995	75.892917
10	249	239	100	321	273		8-14 m wide sandy beach w/30-50% wrack cover. Beach narrower w/more wrack than previous two sections.	37.9393	75.8937
11	115	111	48	39	10	20	Narrow, 5-10 m wide beach w/heavily wrack-lined shoreline. Section ended at <i>S. alterniflora</i> vegetated tip.	37.92995	75.8932
12	273	81	125	50	6	68	Marginal Cdd habitat. Heavily wrack-lined, narrow, 5-10 m wide sandy beach.	37.92845	75.89715
	264						S end of island, north end of small beach		
	1691	1439	974	1298	1095	2464		37.926117	75.895783

Surveys for *C. dorsalis* at Other Maryland Bay Sites. A study of aerial photographs indicated there were some potential sites northeast and west of Janes Island with sandy beaches that might be suitable for *C. dorsalis*. These sites were accessed by boat on July 8 and 13, 2011 and surveyed for the presence of tiger beetles. Knisley and McCann surveyed on July 8 and McCann on July 13. Locations of the sites north of Janes Island are shown in Fig. 5 and survey results in Table 9. These surveys indicated the presence of *C. dorsalis* at 6 new sites (1 found in 2010), all with only small numbers of adults and relatively short sections of suitable beach habitat. Sites ranged from 100 to 400m with relatively narrow beaches. The highest counts were at Jackson Island with 32 adults. Among other sites, 15 adults were found at Pat Island, 6 on the south shore of the Great Annemessex River, 8 adults along the northwest portion of Hazzard Island, and 8 at Drum Point Cove. It is uncertain if these sites support breeding populations, or if the adults present dispersed from Janes Island, the large site to the south.

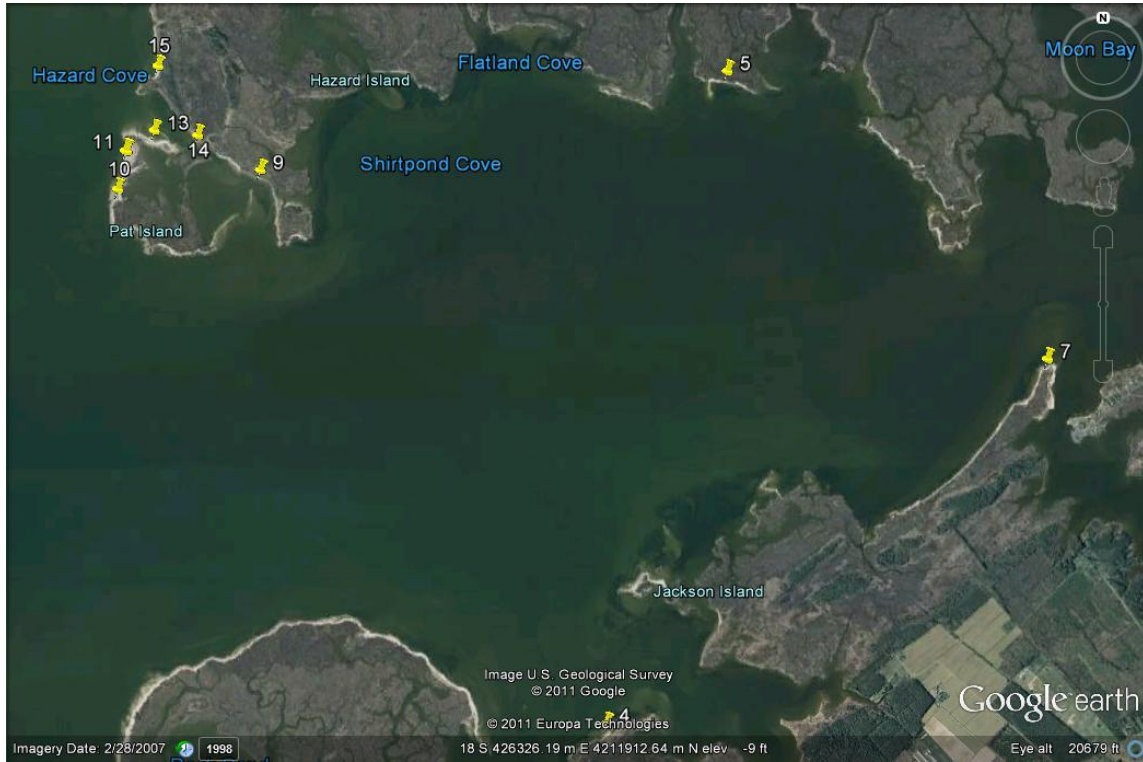
Table 9. Results of surveys for *C. dorsalis* at new sites North of Janes Island in 2010-2011.

WayPt	No. of <i>C. dorsalis</i>	Other Species	Longitude	Latitude	Habitat Notes
1	32	18 C. ht.	426688	4210645	Jackson Island surveyed in 2010
5	0	2 C. mg.	427238	4213814	Gt. Annemessex R. much of beach shell covered
7	6	6 C. mg.	429313	4211988	Gt. Annemessex R. fine sand, narrow, steep beach
9	0	3 C.ht.; 2 C. mg	424266	4213227	Shirtpond Cove, fine sand, narrow beach
10	0	0	423390	4213109	Pat Island, long 2-3 m wide beach, fine sand
11	8	32 C.ht., 9 C.mg.	423441	4213238	Pat Island, long 2-3 m wide beach, fine sand
13	15	18 C.ht; 11 C.mg.	423598	4213456	Pat Island, North, long 2-3 m wide beach, fine sand
14	0	0	423850	4213420	East of above, sandy beach, narrow
15	0	8 C.ht; 10 C.mg.	423656	4213896	Hazard Island, 300 m long sandy beach, narrow
16	8	8 C.ht.	423156	4214731	Hazard Island, NW part, sandy crescent beach, narrow
17	8	26 C.ht.; 5 C.mg.	424179	4216928	Drum Point Cove, narrow beach
18	0	0	426602	4218776	N of 17, steep, 1-3 m wide beach, some shells

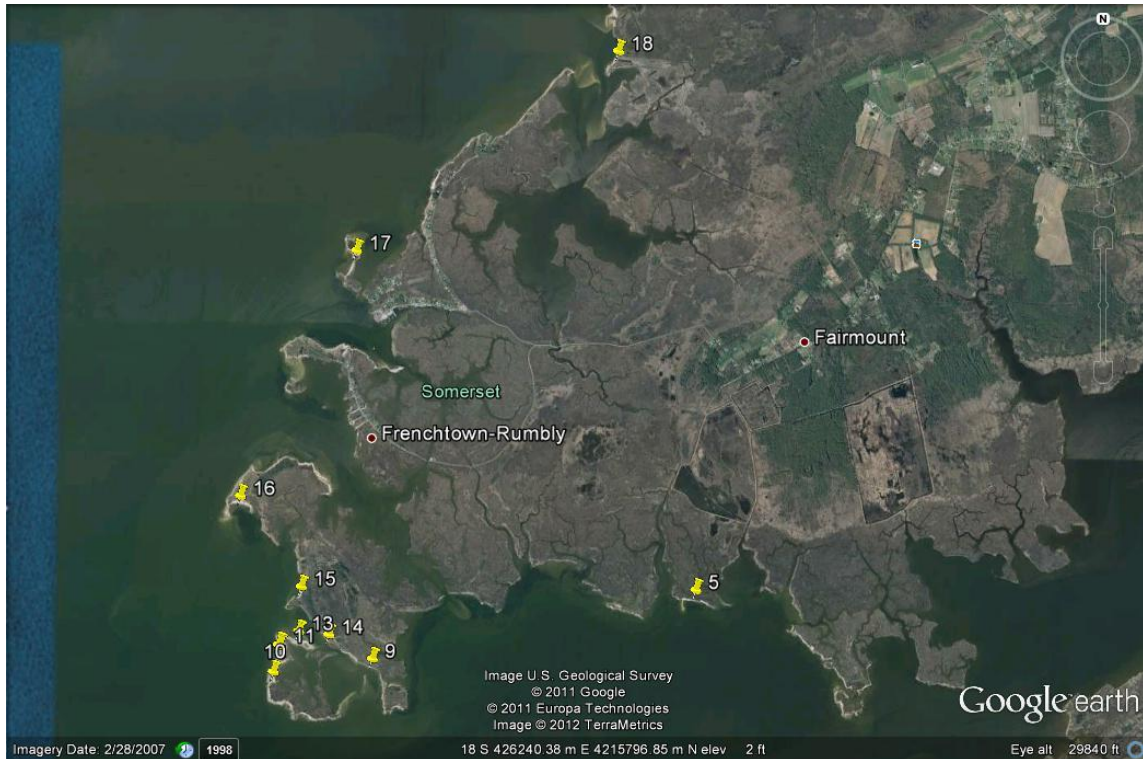
The sites west of Janes with survey results are included in Table 10 (Pry Island and Fishing Bay area are not included) Survey conditions for these sites were optimum (low 90s, light wind, mostly sunny and humid). No adult *C. d. dorsalis* were found at any of these sites, but moderate numbers of *C. hirticollis* and *C. marginata* were present. Initially some of the shoreline sections appeared to be suitable as habitat but upon closer inspection were not long enough or wide enough and with too much wrack or tump. Also, the sand was coarse and the sites possibly too isolated from source populations (Janes and Cedar). In conclusion, none of these sites is likely to support populations of *C. d. dorsalis*.

Fig. 5 A,B,C. Aerial photos of new survey sites for *C. dorsalis* in Upper Chesapeake Bay (sites 1, 7, 11, 13, 16, 17 had *C. dorsalis*). See Table 9 for results).

A



B



C

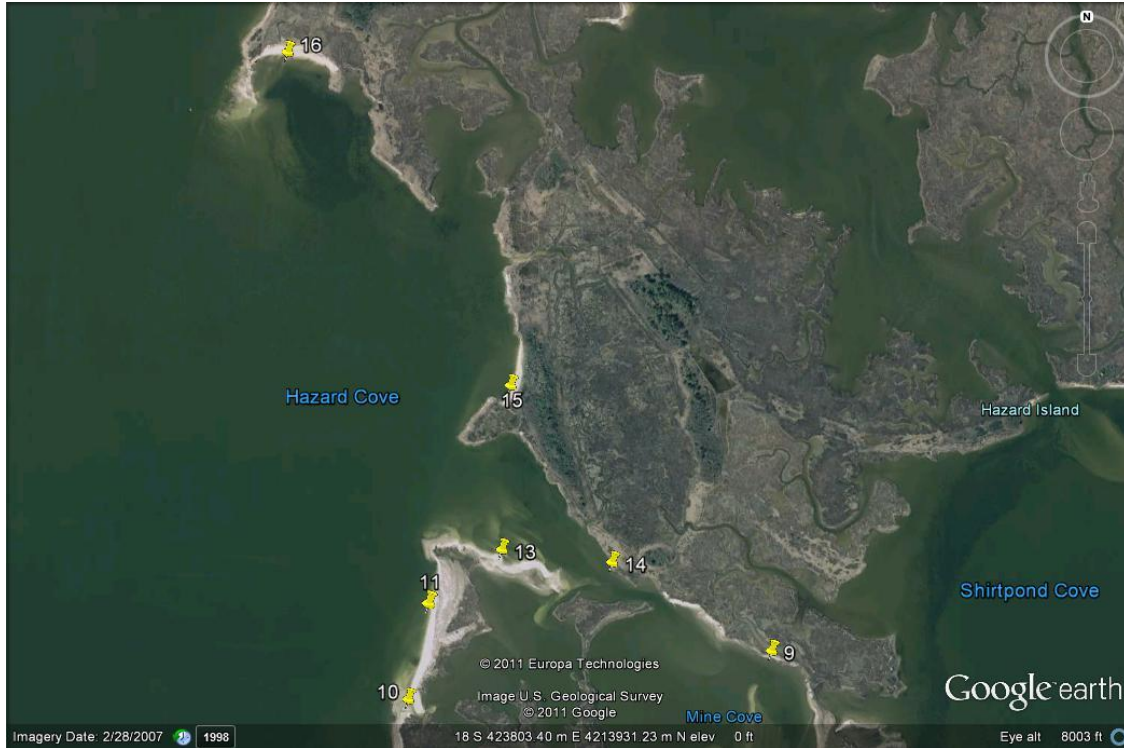
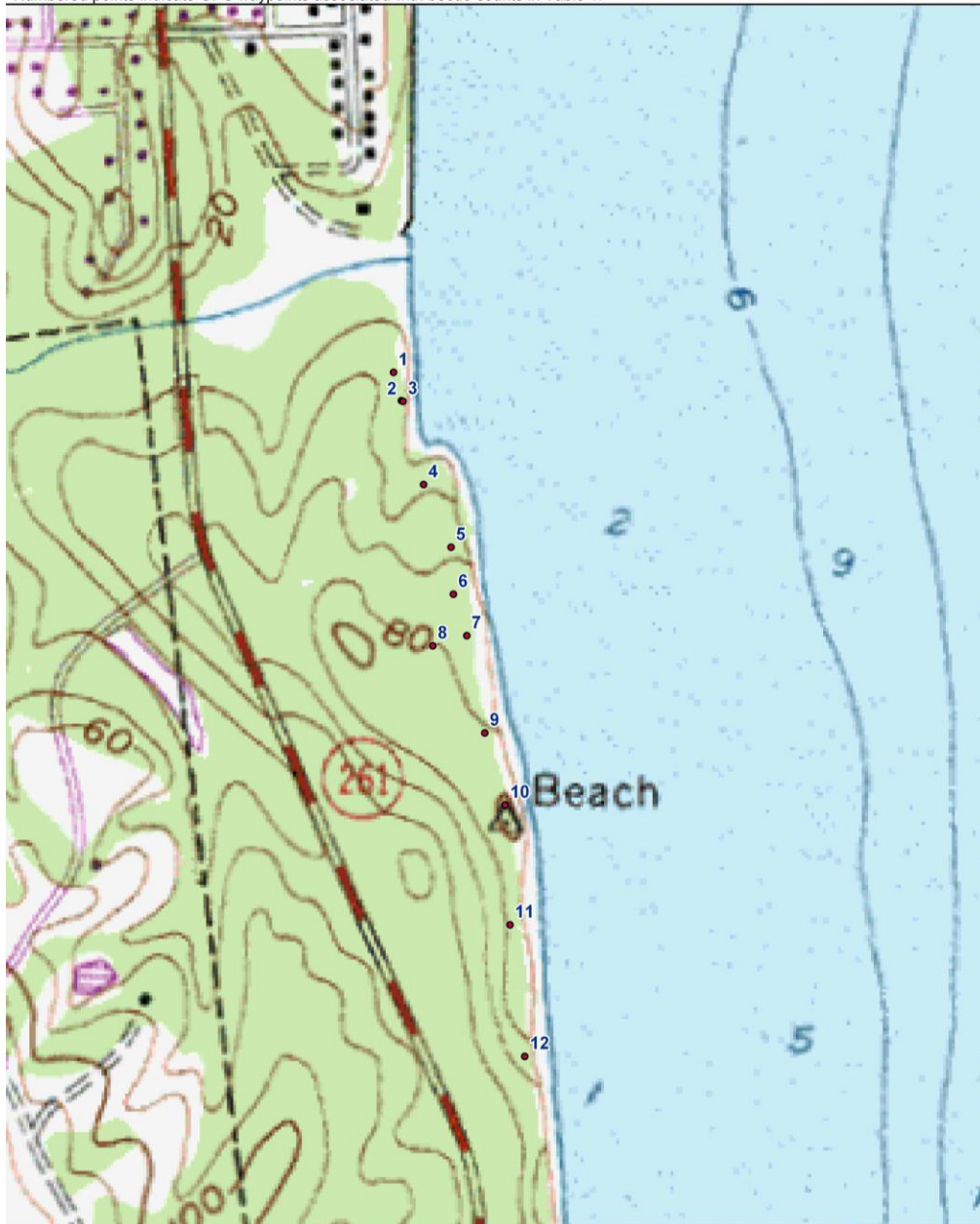


Table 10. Aerial photographs of survey sites north and northwest of Janes Islands in 2011. See Table 9 for results.

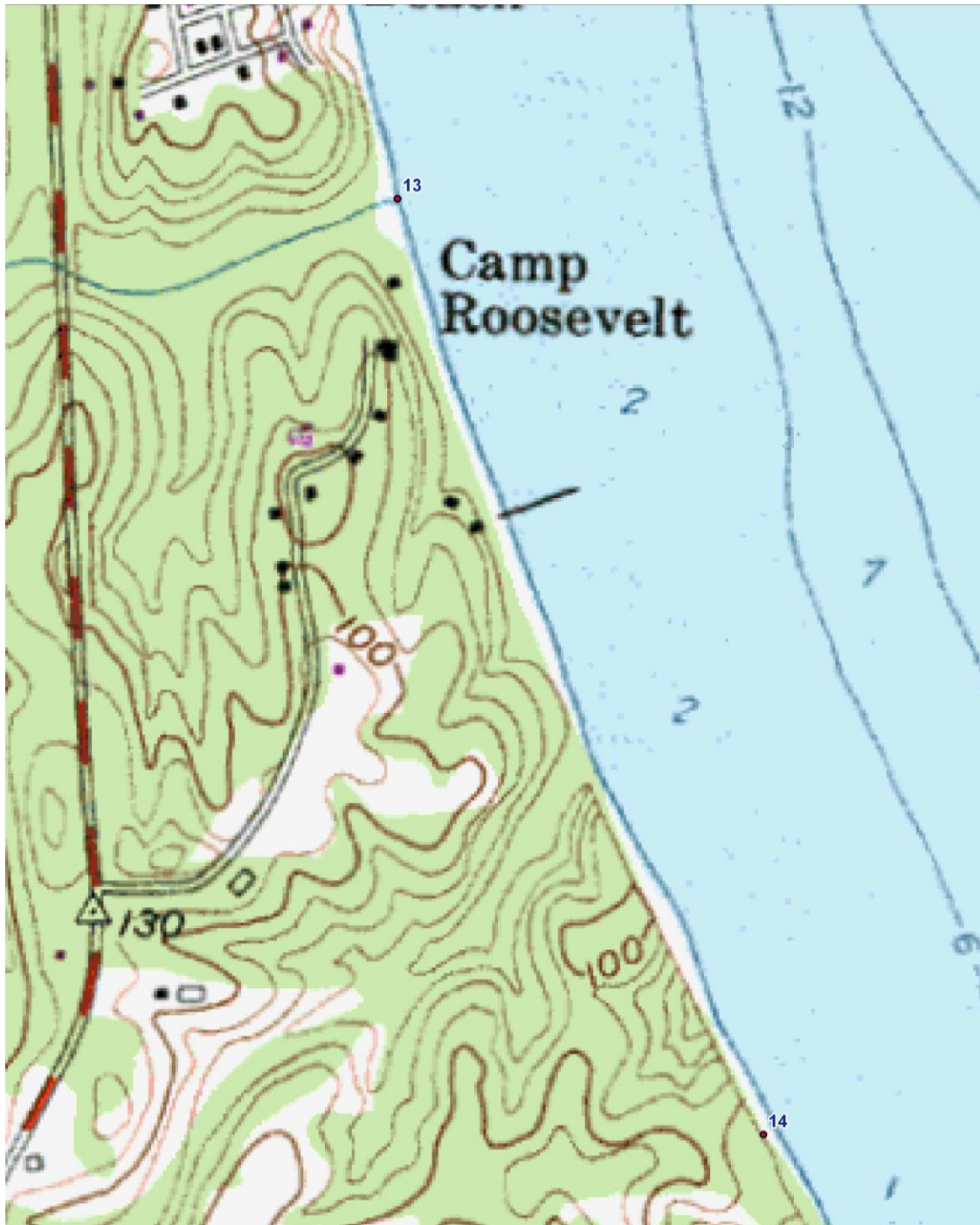
Site	Waypt	Latitude	Longitude	Comments	Start-end time	C. d.	C. dorsalis	C. hirticollis	C. marginata	Shoreline length surveyed (m)	Habitat Notes
Holland Island, SW tip	H1A	38.1159	76.08993	Start waypt	1313-1320	0	28	20		300	4-8 m wide coarse whitish-tan sandy beach with low foredune and scattered wrack and tump.
Holland Island, SW tip	H1B	38.1181	76.09039	End waypt							
Bloodsworth Island	B1A	38.1814	76.08388	Start waypt	1342-1355	0	26	22		650	Extensive stretch of narrow (3-6 m), coarse whitish sandy beach with low foredune, little wrack or tump
Bloodsworth Island	B1B	38.1869	76.08417	End waypt							
Smith Island, N side	SM1A	38.0335	76.03074	Start waypt	1012-1020	0	20	30		223	5-15 m wide sandy beach, coarse whitish-tan sand, well developed foredune
Smith Island, N side	SM1B	38.0326	76.03201	End waypt							
Smith Island, W side	SM2A	37.9966	76.04869	Start waypt	1039-1110	0	24	35		950	Shoreline just S of Big Thoroughfare (W entrance into island interior). Narrow beach, fragmented by tump, small patches of <i>S. alterniflora</i> . Few or now beetles where lg #s of gulls, pelicans resting
Smith Island, W side	SM3A	37.9902	76.04893	End waypt							
South Marsh Island, S side	SO1A	38.0793	76.03792	Start waypt	1229-1237	0	39	2		480	4-5 m wide, coarse sandy beach
South Marsh Island, S side	So1B	38.0817	76.04143	End waypt							
South Marsh Island, S side	SO2A	38.089	76.05082	Start waypt	1247-1252	0	75	15		210	4-10 m wide sandy white beach with clean, coarse whitish-tan sand, well developed low foredune
South Marsh Island, S side	SO2B	38.09	76.06274	End waypt							with beach grass
Nanticoke River, Roaring Pt	R1A	38.2636	75.91741	Start waypt	1441-1500	0	3	9		1100	Very long, white sandy beach but relatively narrow (2-5 m), with well developed foredune.
Nanticoke River, Roaring Pt	R1B	38.2682	75.91265	End waypt							

TOPO MAPS OF ALL CALVERT AND EASTERN
SHORE SITES SHOWING STANDARDIZED
WAYPOINTS (SEE TABLES 4-6 FOR BEETLE
COUNTS)

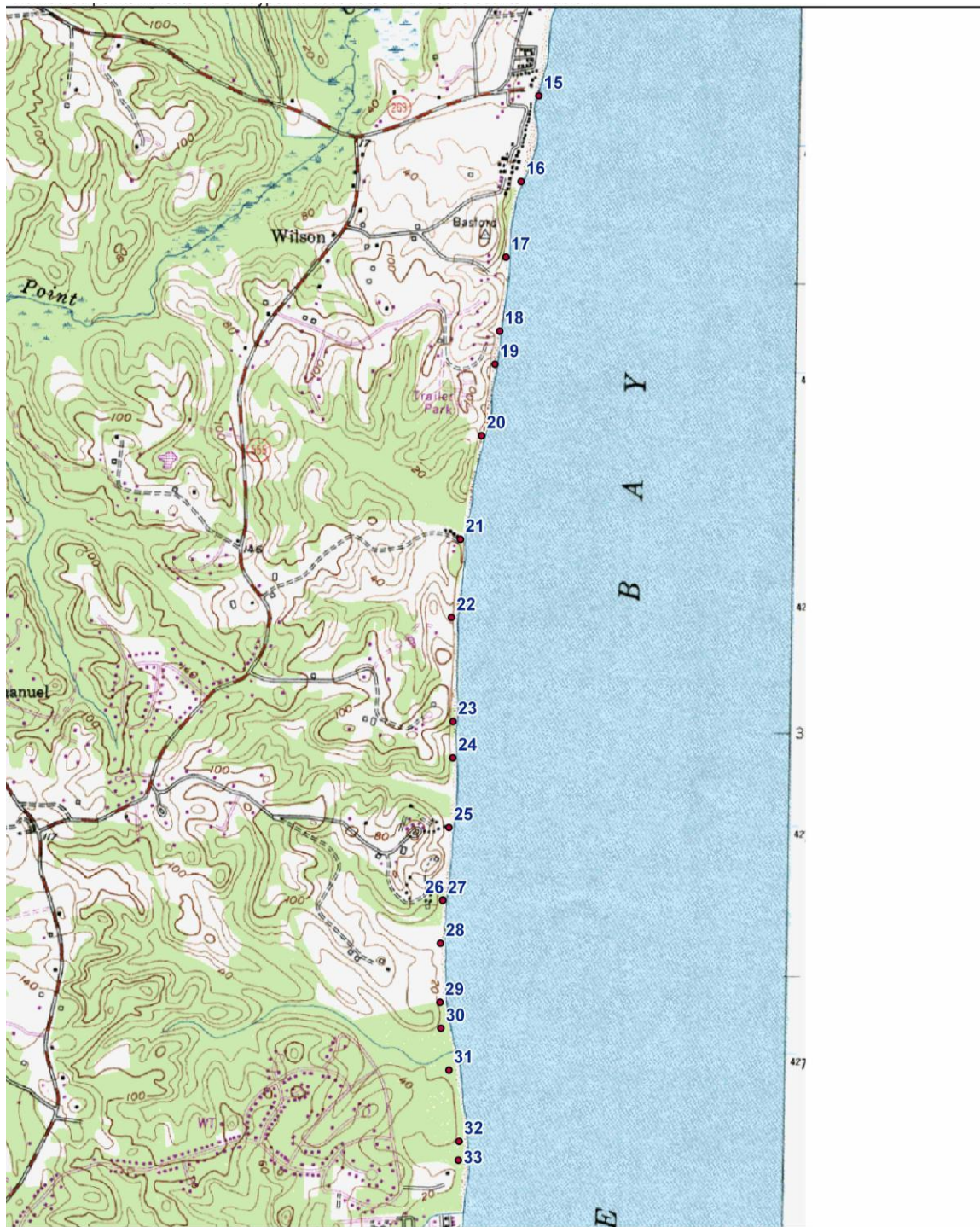
RANDALL CLIFF



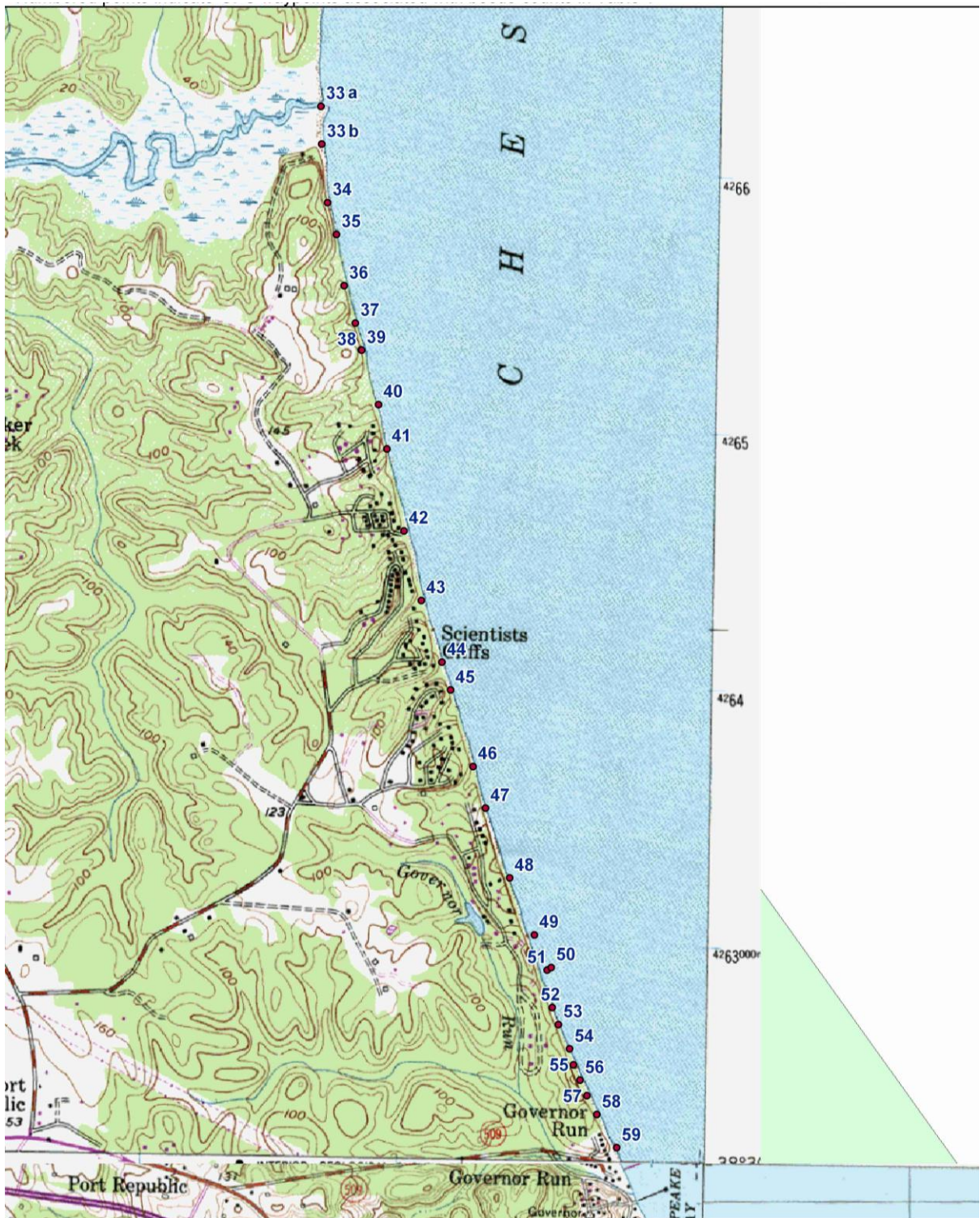
CAMP ROOSEVELT



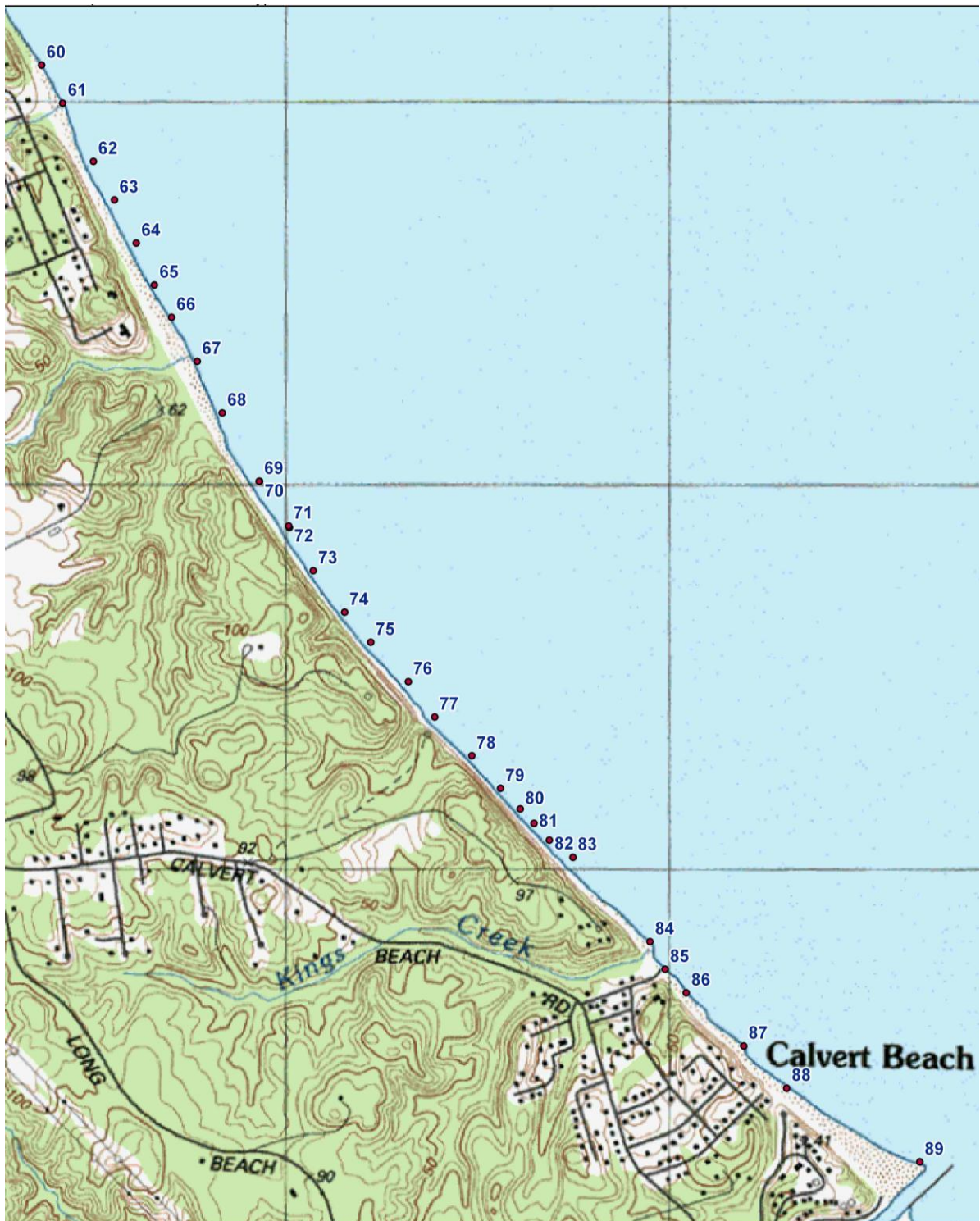
BAYSIDE FOREST



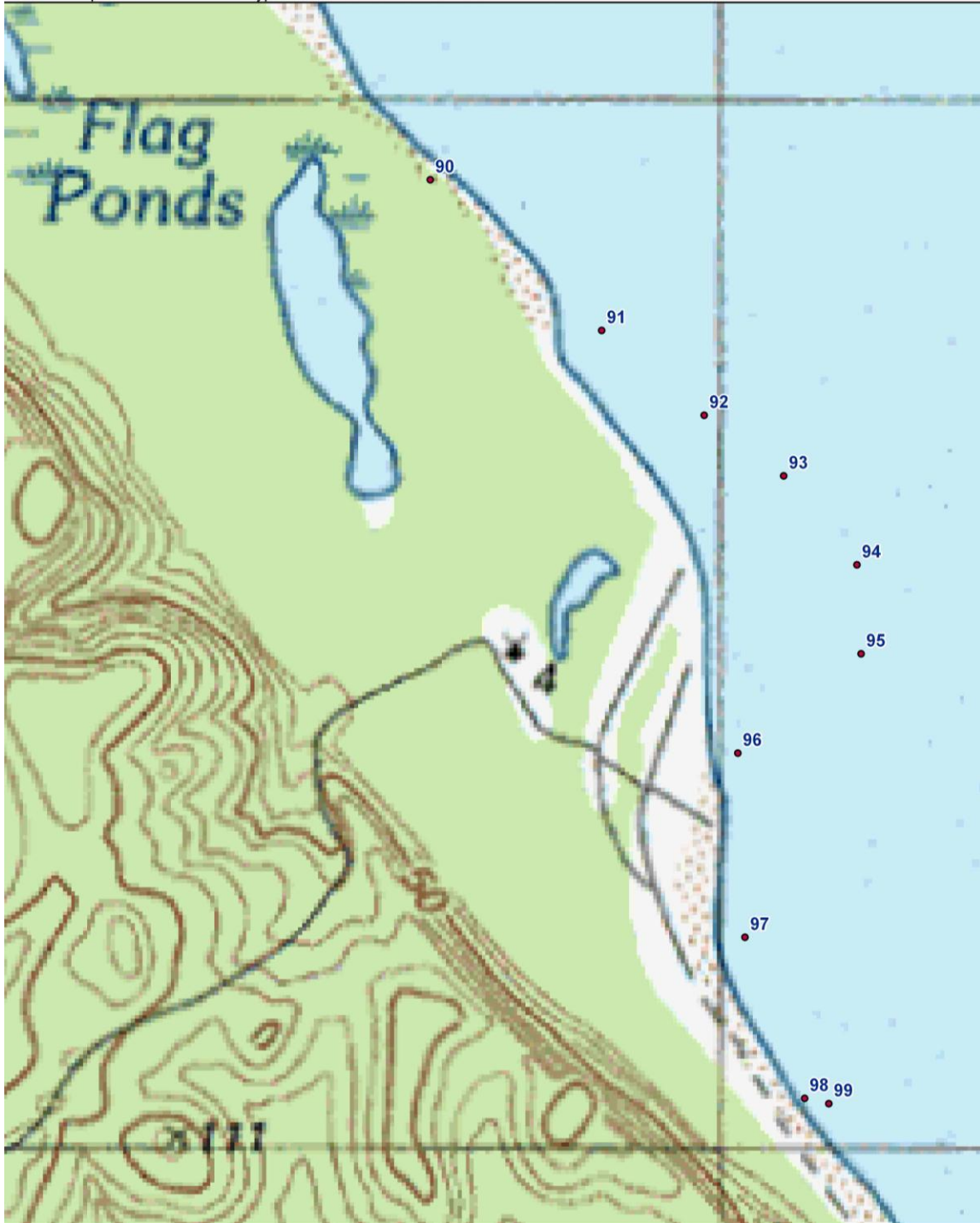
WARRIOR REST/SCIENTIST CLIFFS



WESTERN SHORES/CALVERT BEACH



FLAG PONDS



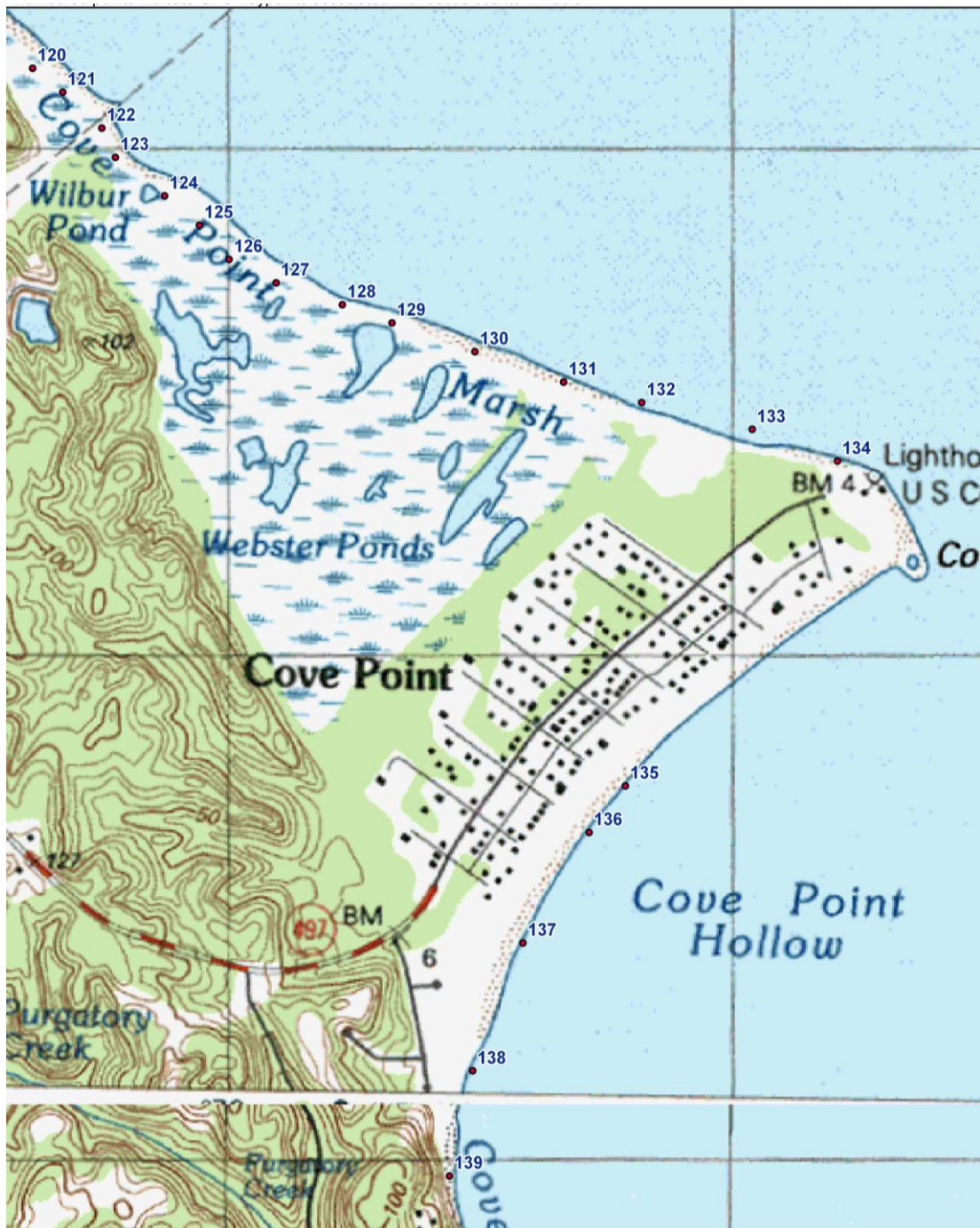
CC NUCLEAR POWER PLANT



CALVERT CLIFFS STATE PARK



COVE POINT



LITTLE COVE POINT

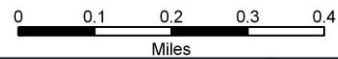


CLIFFS OF CALVERT



GROVE POINT

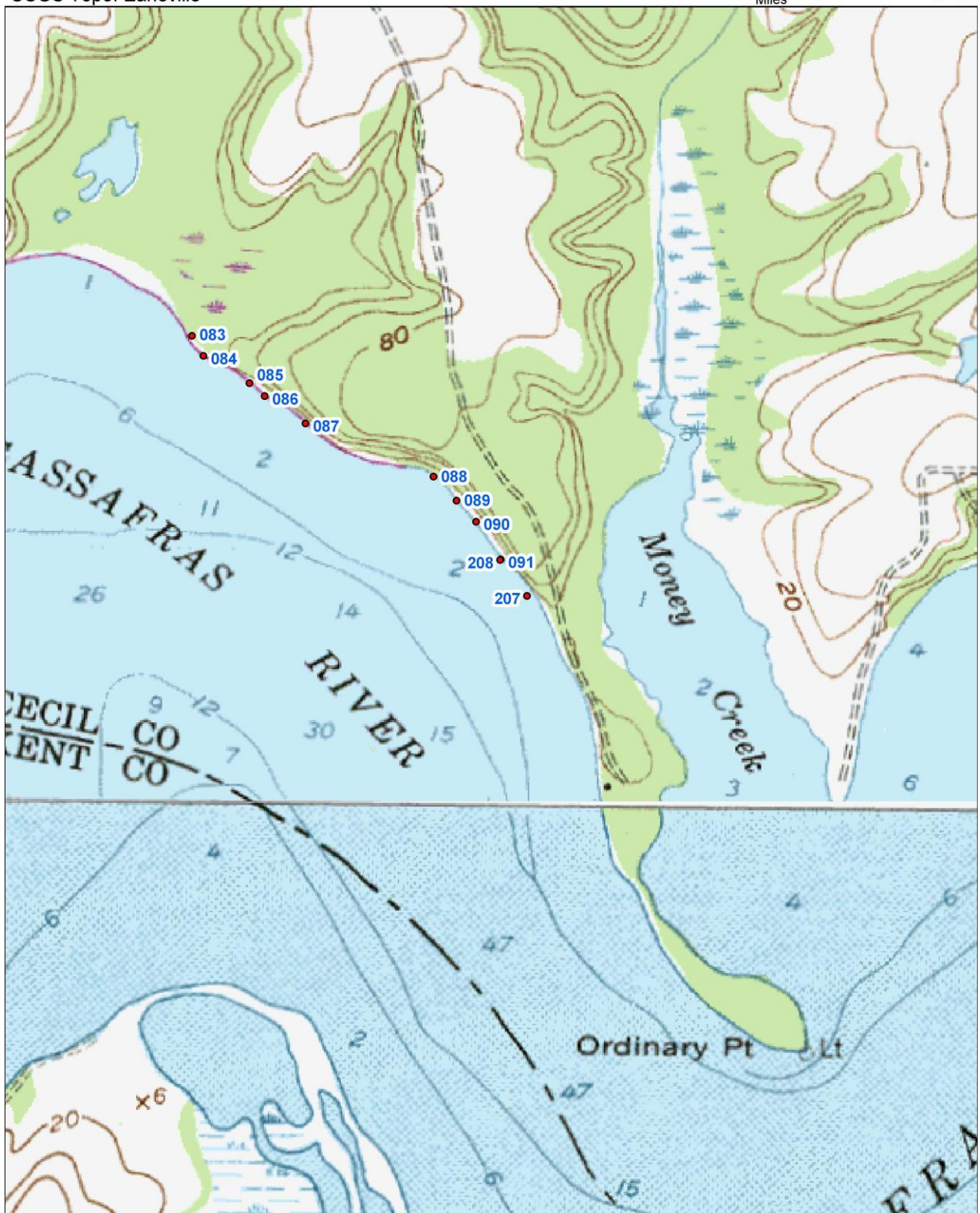
Sites: Grove Point
USGS Topo: Spesutie



ORDINARY POINT

Sites: Ordinary Point
USGS Topo: Earleville

0 0.08 0.16 0.24 0.32
Miles



EAST AND WEST TURNER

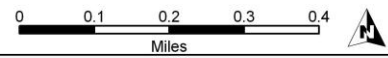
Sites: West Turner and East Turner
USGS Topo: Betterton/Galena

0 0.1 0.2 0.3 0.4
Miles



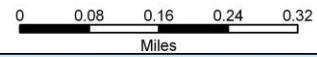
EAST LLOYD

Sites: East Lloyd
USGS Topo: Betterton



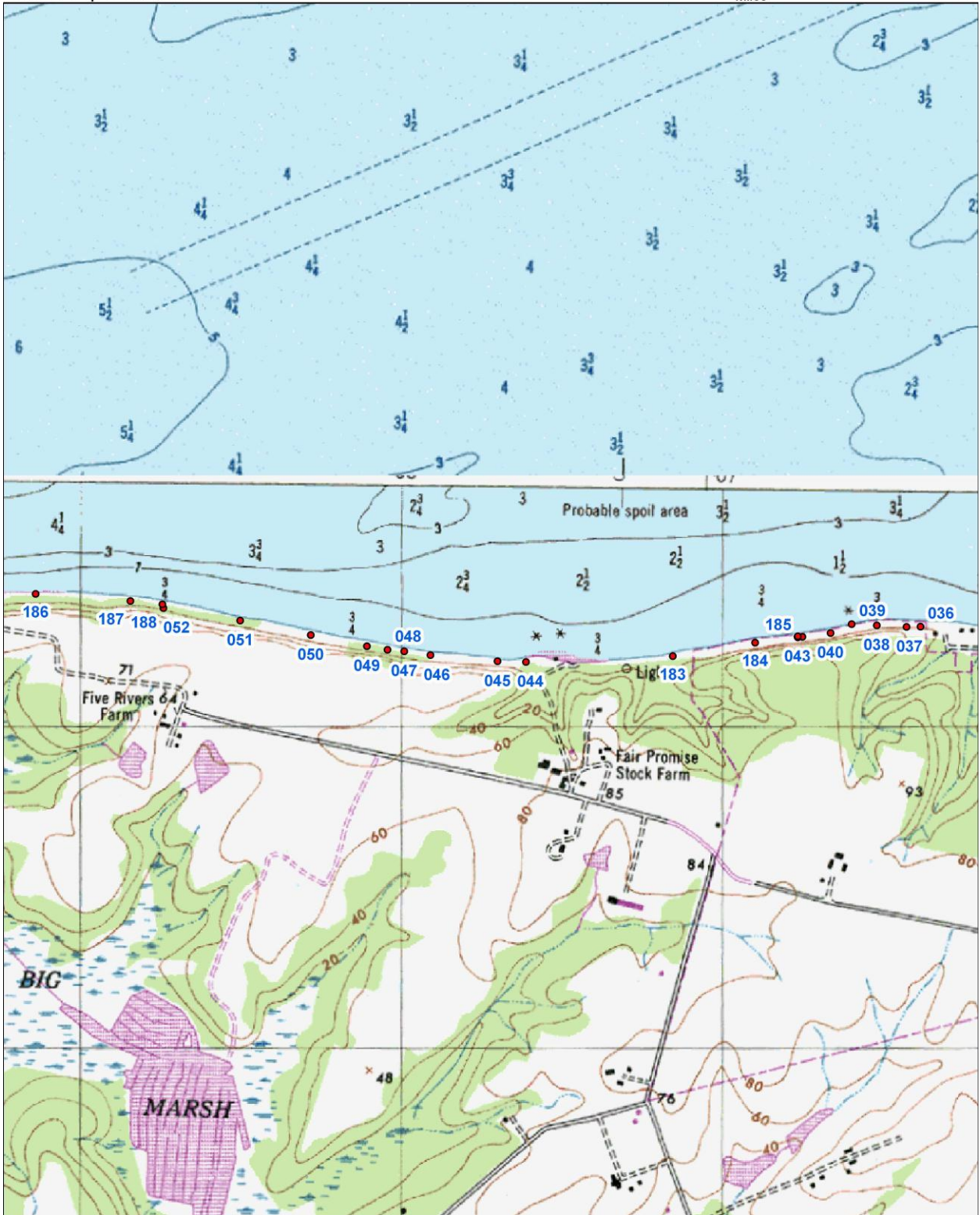
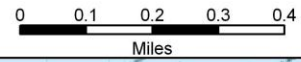
EAST BETTERTON

Sites: East Betterton
USGS Topo: Betterton



WEST BETTERTON

Sites: West Betterton
USGS Topo: Betterton



NORTH STILLPOND

Sites: Southwest Still Pond and North Still Pond
USGS Topo: Hanesville

0 0.1 0.2 0.3 0.4
Miles



NEW SITE-MOUTH OF CABIN JOHN CREEK



JANES ISLAND



CEDAR ISLAND

